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NUMERICAL ANALYSIS OF STIFFENED SHELLS OF REVOLUTION

Volume VI of VII

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16. ABSTRACT

This manual contains engineering programming information for the STARS-2V (Shell Theory Automated for Rotational Structures -2V (Vibration)) digital computer program. The report is written for the engineer who will need to make small alterations to the program, such as incorporating a new geometry, or altering a table size, to fit his specific needs. The sections of the manual each cover one major subroutine. These sections are further subdivided in the following manner where applicable:

A. Subroutine description.

B. A list of pertinent engineering symbols and their FORTRAN coded counterparts.

C. Subroutine flow chart.

D. Subroutine FORTRAN listing.

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VOLUME II. Users' Manual for STARS-2S - Shell Theory Automated for Rotational Structures - 2 (Statics), Digital Computer Program

VOLUME III. Users' Manual for STARS-2B, 2V - Shell Theory Automated for Rotational Structures - 2 (Buckling, Vibrations), Digital Computer Programs

VOLUME IV. Engineer's Program Manual for STARS-2S - Shell Theory Automated for Rotational Structures - 2 (Statics), Digital Computer Program

VOLUME V. Engineer's Program Manual for STARS-2B - Shell Theory Automated for Rotational Structures -2 (Buckling), Digital Computer Program

VOLUME VI. Engineer's Program Manual for STARS-2V - Shell Theory Automated for Rotational Structures -2 (Vibration), Digital Computer Program

VOLUME VII. Satellite Programs for the STARS System

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INTRODUCTION

This manual presents a general description of the STARS-2V digital computer program. FORTRAN IV is used exclusively in writing the various subroutines. The execution of this program requires the use of eleven temporary storage units.

The program was initially written and debugged on the IBM 370-165 computer and then converted to the UNIVAC 1108 computer, where it utilizes approximately 47,000 words of core. Only basic FORTRAN Library routines are required by the program, these being: sine, cosine, absolute value, square root, min 0, max 0, amax 1, amin 1, and random.

For ease and speed in usage, the Table of Contents on the following page has also been laid out to present the call sequence of the program.

CONTENTS

SUBROUTINE MAIN

MAIN is the control link for the entire program. Sizing values are read into the program, as well as information for eigenvalue or determinant accuracy calculations, assumed frequencies and resonance factors, and the material property tables. Calls are made to subroutines RIEMAN and SEGMAT once for each segment in a region; then subroutine REGMAT is called. This procedure is executed once for every region in the structure. Finally a call to subroutine STRMAT is made. If the analysis involves prestressing, subroutines INITAL and LEBEGE are called. Otherwise the control link loops back and resets the clues for the calculation of dynamic stiffness matrices.

In the calculation loop for the dynamic stiffness matrices the program proceeds as above to STRMAT. Next EIGVAL or DETERM are called to calculate eigenvalues or evaluate a determinant as per user input. If these calculations satisfy convergence criteria, subroutines BCVECT, INITAL and LEBEGE are called. If convergence criteria are not satisfied the program will loop until such satisfaction is obtained.

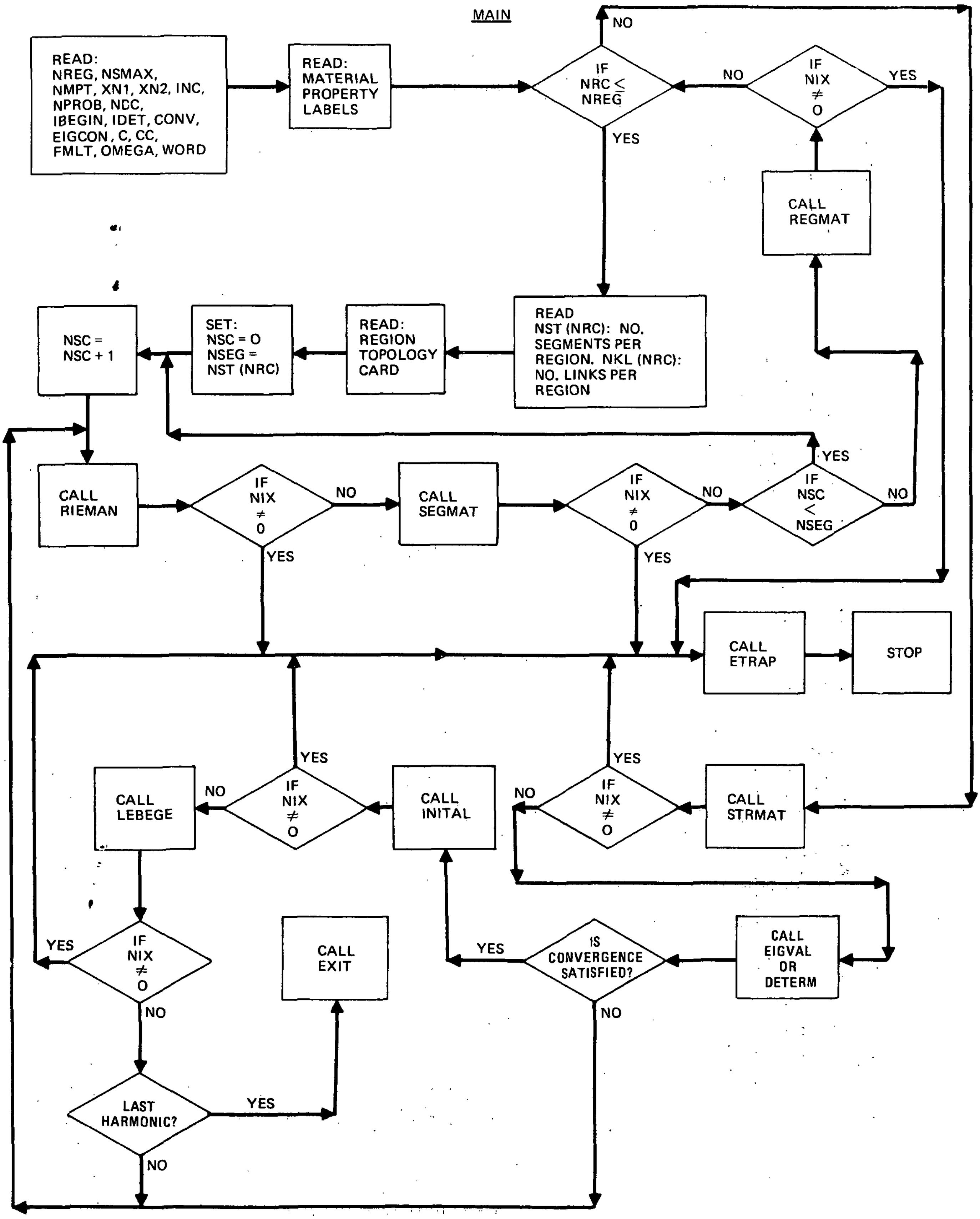
In a multi-harmonic eigenvalue search the whole procedure loops on the harmonic number.

There are also several counters in this control link. These are defined as follows:

- NSC - Counts the calls to subroutines RIEMAN and SEGMAT, from 1 to the number of segments within a region.
- NRC - Counts the calls to subroutine REGMAT, from 1 to the number of regions in the structure.
- ICYC - Cycle counter (counts harmonics).
- NPASS - Pass counter (counts passes necessary to converge in a single harmonic).

The block data and overlay listings are included in this section.

MAIN


READ: NREG, NSMAX, NMPT, XN1, XN2, INC, NPROB, NCC, IBEGIN, IDET, CONV, EIGCON, C, CC, FMLT, OMEGA, WORD
READ: MATERIAL PROPERTY LABELS
IF NRC ≤ NREG
NO
YES
IF NIX ≠ O
NO
YES
CALL REGMAT
READ NST (NRC): NO. SEGMENTS PER REGION. NKL (NRC): NO. LINKS PER REGION
READ: REGION TOPOLOGY CARD
SET: NSC = O NSEG = NST (NRC)
NSC = NSC + 1
CALL RIEMAN
IF NIX ≠ 0
NO
YES
CALL SEGMAT
IF NIX ≠ 0
NO
YES
IF NSC < NSEG
YES
NO
CALL ETRAP
STOP
CALL LEBEGE
NO
IF NIX ≠ O
YES
CALL INITAL
YES
NO
IF NIX ≠ O
CALL STRMAT
YES
IF NIX ≠ O
NO
CALL EXIT
YES
IS CONVERGENCE SATISFIED?
CALL EIGVAL OR DETERM
NO
LAST HARMONIC?
YES
NO

```
FØR,IS BLDATA,BLDATA
      BLØCK DATA
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)
      DATA STRGØ /11.0,13.0,21.0,31.0,12.0,14.0,15.0/
      DATA THERM /4HTHST,4HNØTH,4HTHCN,4HTHIN/
      DATA MATER /4HISØT,4HØRTH,4HSTIF/
      DATA SEGTAB/4HST10,4HTHIC,4HRWAF,4HRWA1,4HRWA2,4HRWA3,4HISG1,
     1            4HISG2,4HISG3,4HST11,4HST12,4HST13/
      DATA FACE /4HSING,4HEQUA,4HUNEQ,4HBLAN/
      CØMMØN/WINTER/INDIC8
      CØMMØN /BØND/M,L
       END
```

```
FØR,IS MAIN,MAIN
      INTEGER SAVJTC,SAVSTP,SEGTAB, Q ,THICK,TYPE                       200010
      INTEGER XN1,XN2,XN                                                200020
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                 200030
      DØUBLE PRECISIØN YCØRR                                            200040
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)         200050
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                            200060
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH           200070
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)  200080
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB 200090
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE 200100
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS            200110
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)       200120
      CØMMØN /LYCØRR/ YCØRR(80)                                         200130
      CØMMØN /ARING/ NRING(28),AMAT(30,4),ISTART,NUMVEC,MSEIG           200140
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ        200150
      DIMENSIØN QVEC(128,2),AWØRD(6)                                    200160
      DATA AWØRD/-FREV-,-VPRE-,-CRSP-,-PCRS-,-CRSR-,-PCSR-/             200170
    1 WRITE(6,1726)                                                     200220
 1726 FØRMAT(1H1)                                                       200230
      REWIND 1                                                          200240
      REWIND 2                                                          200250
      REWIND 3                                                          200260
      REWIND 4                                                          200270
      REWIND 8                                                          200280
      REWIND 9                                                          200290
      REWIND 10                                                         200300
      REWIND 11                                                         200310
      REWIND 12                                                         200320
      REWIND 13                                                         200330
      REWIND 14                                                         200340
      NIX = 0                                                           200350
      Q=5                                                               200360
      READ(5,1001,END=555) (STØRY(I),I=1,16)                            200370
 1001 FØRMAT  (16A4)                                                    200380
      READ(5,1002) NREG,NSMAX,NMPT,XN1,XN2,INC,NPRØB,NBC,IBEGIN,        200390
     1              IDET,CØNV,EIGCØN,C,CC,FMLT,ØMEGA,WØRD,NUMVEC,MSEIG  200380
 1002 FØRMAT(I2,I3,6I2,2X,2I2,5F7.0,E14.7/A4,I6,I5)                     200390
      XN = XN1                                                          200420
      WRITE(6,602) NSMAX,NREG,NMPT,NPRØB,NBC,XN1,XN2,INC                200430
  602 FØRMAT(////19X,93HUNSYMMETRIC, ØRTHØTRØPIC, REINFØRCED SHELL ANALY 200440
     1SIS WITH CØUPLING ØF AT MØST 29 SHELL REGIØNS//62X,-STARS-2V-//   200450
     2 56X,-AS ØF NØVEMBER 1, 1972-////8X,21HNUMBER ØF SEGMENTS = ,I3,  200460
     321H NUMBER ØF REGIØNS = ,I2,43H NUMBER ØF MATERIAL PRØPERTY TABLES 200470
     4 USED = ,I2,22H NUMBER ØF PRØBLEMS = ,I2//8X,-NUMBER ØF BØUNDARY C 200480
     5ØNDITIØN MATRICES = -,I2////40X,-VIBRATIØN HARMØNICS (N) = -,I2,  200490
     6 - TØ -,I2,- INCREMENTED BY -,I2)                                 200500
      DØ 1500 J=1,6                                                     200510
      IF (AWØRD(J)-WØRD) 1500,1501,1500                                 200520
 1500 CØNTINUE                                                          200530
      GØ TØ 8001                                                        200540
 1501 IWØRD = J                                                         200550
      GØ TØ (1510,1511,1512,1513,1514,1515),IWØRD                       200560
 1510 WRITE(6,1520)                                                     200570
 1520 FØRMAT(///55X,-FREE VIBRATIØN PRØBLEM-)                           200580
      GØ TØ 1530                                                        200590
 1511 WRITE(6,1521)                                                     200600
 1521 FØRMAT(///51X,-PRESTRESSED VIBRATIØN PRØBLEM-)                    200610
      GØ TØ 1530                                                        200620
 1512 WRITE(6,1522)                                                     200630
 1522 FØRMAT(///55X,-CRITICAL SPEED PRØBLEM-)                           200640
```

```
      GØ TØ 1530                                                        200650
 1513 WRITE(6,1523)                                                     200660
 1523 FØRMAT(///49X,-PRESTRESSED CRITICAL SPEED PRØBLEM-)               200670
      GØ TØ 1530                                                        200680
 1514 WRITE(6,1524)                                                     200690
 1524 FØRMAT(///51X,-PULSING CRITICAL SPEED PRØBLEM-)                   200700
      GØ TØ 1530                                                        200710
 1515 WRITE(6,1525)                                                     200720
 1525 FØRMAT(///45X,-PRESTRESSED PULSING CRITICAL SPEED PRØBLEM-)       200730
 1530 CØNTINUE                                                          200740
      KBC = 0                                                           200750
      IF (IWØRD.GE.3) KBC = 1                                           200760
      WRITE(6,605)  (STØRY(I),I=1,16)                                   200770
  605 FØRMAT(8(/),8X,16A4,18(/),80X,35HFØR INFØRMATIØN CALL   V. SVALBØN 200780
     1AS/117X,14H(516) 575-7701/103X,10HP. ØGILVIE)                     200790
      IF (CØNV.EQ.0.0) CØNV = 0.01                                      200800
      CØNVER = CØNV                                                     200810
      IF (C.EQ.0.0) C = 0.05                                            200820
      IF (CC.EQ.0.0) CC = 1.0                                           200830
      D = CC*C                                                          200840
      F = C                                                             200850
      MDET = 0                                                          200860
      KDET = 0                                                          200870
      ØMEGA = ØMEGA*ØMEGA                                               200880
      FMLT = 1.0+FMLT*FMLT                                              200890
      XNL(1) = 0.0                                                      200900
      XNL(2) = 0.0                                                      200910
      XNL(3) = 0.0                                                      200920
      NLCASE = NPRØB                                                    200930
      NH = 0                                                            200940
      XN = 0                                                            200950
      IF (IWØRD.EQ.1) XN = XN1                                          200951
      ICYC = 1                                                          200960
      NPASS = 0                                                         200970
      NPAS = 0                                                          200980
      MØM=0
      KNBC = 2                                                          200990
      LINPUT = 1                                                        201000
      JNBC = IABS(NBC)                                                  201010
      EIGCØN = ABS (EIGCØN)                                             201020
      NRØW=0                                                            201030
      KK=-1                                                             201040
      NSAVE=0                                                           201050
      DØ 13 I=1,NMPT                                                    201060
      KK=KK+2                                                           201070
      NXMAT(KK)=NRØW+1                                                  201080
      II=NRØW+1                                                         201090
      READ(5,1004) STD(I),TYPE                                          201100
 1004 FØRMAT (A4,6X,A4,6X)                                              201110
      NRØW = 11                                                         201120
      DØ 11 L=1,3                                                       201130
   11 IF(TYPE.EQ.MATER(L)) GØTØ 12                                      201140
      GØ TØ 8000                                                        201150
   12 CØNTINUE                                                          201160
      IF(L.EQ.1) NRØW=4                                                 201170
      IF(L.EQ.2) NRØW=7                                                 201180
       LLL=NSAVE+NRØW                                                   201190
      READ (5,1005) ((XMAT(M,J),J=1,10),M=II,LLL )                      201200
 1005 FØRMAT (5E14.7)                                                   201210
      NRØW=NSAVE+NRØW                                                   201220
      NXMAT(KK+1)=LLL                                                   201230
```

```
   13 NSAVE=NRØW                                                          201240
      READ(5,2000)                                                        201250
 2000 FØRMAT(1X)                                                          201260
  100 NPASS = NPASS+1                                                     201270
      REWIND 13                                                           201360
      REWIND 4                                                            201370
      IF (NH.EQ.0) GØ TØ 618                                              201380
      IF (ICYC.GT.1.AND.NPASS.EQ.1) GØ TØ 618                             201390
      IF (NPASS.LT.3.AND.XN.EQ.XN1.AND.XNL(2).EQ.0.0.AND.IWØRD.NE.1)      201410
     1    GØ TØ 618                                                       201410
      NPAS = NPAS+1                                                       201420
      WRITE(6,1726)                                                       201430
      WRITE(6,607) XN                                                     201440
      WRITE(6,611) NPAS                                                   201450
  618 REWIND 10                                                           201460
      DØ 99 NRC=1,NREG                                                    201470
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,1726)                           201480
      IF (Q.EQ.5) READ(5,1003) NST(NRC),NKL(NRC),NRING(NRC),STØRY         201490
 1003 FØRMAT(3I2,16A4)                                                    201500
      IF (NH.NE.0) GØ TØ 613                                              201510
      WRITE(6,606)NRC,NST(NRC),NKL(NRC)                                   201520
  606 FØRMAT(/////////////////////////58X,13HREGIØN NUMBER,I3//35X,10HTH  201530
     1ERE ARE ,I2,14H SEGMENTS AND ,I2,35H KINEMATIC LINKS WITHIN THIS R  201540
     2EGIØN)                                                              201550
      GØ TØ 610                                                           201560
  613 IF (IBEGIN.EQ.0) GØ TØ 610                                          201570
      WRITE(6,612) NRC,NST(NRC),NKL(NRC)                                  201580
  612 FØRMAT(///58X,13HREGIØN NUMBER,I3//35X,10HTHERE ARE ,I2,14H SEGMEN  201590
     1TS AND ,I2,35H KINEMATIC LINKS WITHIN THIS REGIØN)                  201600
      WRITE(6,607) XN                                                     201610
  607 FØRMAT(/57X,-HARMØNIC (N) =-,I3)                                    201620
      IF (NPAS.NE.0) WRITE(6,611) NPAS                                    201630
  611 FØRMAT(/61X,-ESTIMATE-,I3)                                          201640
  610 CØNTINUE                                                            201650
      IF (Q.EQ.5) READ(5,1006) JRTIC(NRC),JRSTØP(NRC),STØRY               201660
 1006 FØRMAT(5X,2I5,16A4)                                                 201670
      NSEG = NST(NRC)                                                     201680
  201 NSC=0                                                               201690
  101 NSC=NSC+1                                                           201700
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,1726)                           201710
      CALL RIEMAN                                                         201720
      IF (NIX.NE.0) GØTØ 8888                                             201730
      CALL SEGMAT                                                         201740
      IF (NIX.NE.0) GØTØ 8888                                             201750
      IF(NSC.LT.NSEG) GØ TØ 101                                           201760
      NSC= 0                                                              201770
  102 CALL REGMAT                                                         201780
      IF(NIX.LT.0) GØ TØ 8888                                             201790
      NIX = 0                                                             201800
       REWIND 2                                                           201810
       REWIND 3                                                           201820
   99 CØNTINUE                                                            201830
      REWIND 11                                                           201840
      CALL STRMAT (ICYC)                                                  201860
      IF (NIX.NE.0) GØTØ 8888                                             201860
      IF (NH.EQ.0) GØ TØ 200                                              201870
      IF (NPASS-2) 71,72,198                                              201880
   72 LINPUT = 0                                                          201890
      IF (XN.NE.XN1) GØ TØ 198                                            201900
      IF ((XN.EQ.0.AND.(IWØRD.EQ.3.ØR.IWØRD.EQ.5)).ØR.IWØRD.EQ.1)         201920
     1     GØ TØ 198                                                      201921
```

```
 71 IF (IWØRD.GE.3) XNL(2) = 1.0                                      201930
    XNL(3) = FMLT                                                     201930
    LINPUT = 0                                                        201940
    REWIND 1                                                          201950
    GØ TØ 100                                                         201960
198 IF (IDET.EQ.1.AND.NPAS.GT.1) GØ TØ 707                            201970
520 CALL EIGVAL (CØNVER,EIG,NZ,IBEGIN,QVEC,NPAS)                      202010
    IF (NPAS.EQ.1) GØ TØ 710                                          201990
    IF(NPAS.EQ.2.AND.XNL(3)/EIG.GT.0.0)  MØM=1
    AD = (2.0*EIG+1.0)/3.0                                            202000
    IF(MØM.EQ.1) AD=EIG
    B = XNL(3)/FMLT                                                   202010
    A = B*AD                                                          202020
    IF (ABS(ABS(EIG)-1.0).LE.CØNVER) A = B*EIG                        202030
    IF (ABS(ABS(EIG)-1.0).LE.CØNVER.AND.IDET.EQ.1) GØ TØ 711          202040
    XNL(2) = A                                                        202050
    IF (KBC.EQ.0) XNL(2) = 0.0                                        202060
    XNL(3) = A*FMLT                                                   202070
    GØ TØ 711                                                         202080
710 XNL(2) = XNL(2)*EIG                                               202090
    XNL(3) = XNL(3)*EIG                                               202100
    KFLAG = XNL(3)/ABS(XNL(3))                                        202110
    A = EIG                                                           202120
    GØ TØ 711                                                         202130
707 CALL DETERM (NZ,MDET)                                             202140
    G = (1.0-KFLAG*F)                                                 202150
    IF (MDET.EQ.KDET.ØR.KDET.EQ.0) GØ TØ 709                          202160
    XNL(2) = XNL(2)/G                                                 202170
    XNL(3) = XNL(3)/G                                                 202180
    IF (F.GT.D) GØ TØ 521                                             202190
    CØNVER = 1.E8                                                     202200
    GØ TØ 520                                                         202210
521 F = F*0.1                                                         202220
    MDET = -MDET                                                      202230
709 XNL(2) = XNL(2)*G                                                 202240
    XNL(3) = XNL(3)*G                                                 202250
    KDET = MDET                                                       202260
    A = XNL(3)/FMLT                                                   202270
711 CØNTINUE                                                          202280
    WRITE(6,700) A                                                    202290
700 FØRMAT(//5X,-THE CURRENT LØAD MULTIPLICATIØN FACTØR =-,1PE14.6)   202300
    CURF = SQRT(ØMEGA*A)                                              202310
    WRITE(6,701) CURF                                                 202320
701 FØRMAT(//5X,-THE CURRENT FREQUENCY =-,1PE14.6,1X,-RADIANS/SECØND-) 202330
    IF (ABS(A).LT.EIGCØN.ØR.EIGCØN.EQ.0.0) GØ TØ 510                  202340
    WRITE(6,511)                                                      202350
511 FØRMAT(/  4X,-EIGENVALUE UPPER LIMIT EXCEEDED IN THIS HARMØNIC.-/) 202360
    GØ TØ 500                                                         202370
510 CØNTINUE                                                          202380
    IF (ABS(ABS(EIG)-1.0).LE.CØNVER) GØ TØ 199                        202390
    REWIND 1                                                          202400
    GØ TØ 100                                                         202410
199 NPRØB = 2                                                         202470
    CALL BCVECT (NZ,QVEC,NØJS,JRTIC,JRSTØP,NREG)                      202430
200 CØNTINUE                                                          202440
    IF (IWØRD.EQ.1.AND.NH.EQ.0) GØ TØ 500                             202450
    CALL INITAL                                                       202460
    REWIND 13                                                         202470
    CALL LEBEGE                                                       202480
500 CØNTINUE                                                          202490
    REWIND 1                                                          202500
```

```
      NPRØB = C                                                         202510
      IF (NH.EQ.0) GØ TØ 55                                             202520
      ICYC = ICYC+1                                                     202530
      NPASS = 0                                                         202540
      NPAS = 0                                                          202550
      MØM=0
      MDET = 0                                                          202560
      KDET = 0                                                          202570
      F = C                                                             202580
      KNBC = KNBC+1                                                     202590
      LINPUT = 0                                                        202600
      IF (KNBC.LE.JNBC) LINPUT = 1                                      202610
      XN = XN+INC                                                       202680
      IF (XN.GT.XN2) GØ TØ 1                                            202630
   55 GØ TØ (91,92,93,92,93,92),IWØRD                                   202640
   91 XNL(3) = 1.0                                                      202650
      IF (ICYC.GT.1) XNL(3) = 0.0                                       202660
      GØ TØ 95                                                          202670
   92 XNL(1) = 1.0                                                      202680
      XNL(2) = 0.0                                                      202690
      XNL(3) = 0.0                                                      202700
      GØ TØ 95                                                          202710
   93 IF (XN1.NE.0.ØR.ICYC.GT.1) GØ TØ 94                               202720
      XNL(2) = 1.0                                                      202730
      XNL(3) = FMLT                                                     202740
      GØ TØ 95                                                          202750
   94 XNL(2) = 0.0                                                      202760
      XNL(3) = 0.0                                                      202770
   95 CØNTINUE                                                          202780
      IF (NH.NE.0) GØ TØ 100                                            202790
      Q = 1                                                             202810
      NH = 1                                                            202820
      LINPUT = 0                                                        202830
      IF (NBC.LT.0) LINPUT = 1                                          202840
      IF (XN.NE.XN1.AND.NBC.GE.2) LINPUT = 1                            202890
      IF (LINPUT.EQ.0) JNBC = JNBC+1                                    202860
      XN = XN1                                                          202901
      GØ TØ 100                                                         202870
  555 CALL EXIT                                                         202880
 8000 IERRØR=8000                                                       202890
      NERRØR= 1                                                         202900
      GØ TØ 8888                                                        202910
 8001 WRITE(6,8002)                                                     202920
 8002 FØRMAT(/  4X,-INITIAL DATA CLUE SPELLED INCØRRECTLY.-)             202930
      STØP                                                              202940
 8888 CØNTINUE                                                          202950
      CALL ETRAP                                                        202960
      STØP                                                              202970
       END                                                              202980
```

OVERLAY

```
SEG RØØT
IN NBF24$
IN MAIN,BLDATA
SEG RIE*,(RØØT)
IN RIEMAN,SETUP,RØBØT,GEØMET,PLINE,PLICØ
SEG DF1*,(RIE)
IN DIF1
SEG DF2*,(RIE)
IN DIFF2
SEG SGMAT*,(RØØT)
IN SEGMAT,SKEVN2
SEG SWCH*,(RØØT)
IN SWITCH,TRIEQ,FUTILE
SEG RING*,(SWCH)
IN RINGER
SEG REG*,(RING)
IN REGMAT,CHASE
SEG STR*,(RING)
IN STRMAT,FLEX
SEG EIG*,(SWCH)
IN EIGVAL,CØMPAK,EIGEN,DØTPRØ,SYMEIG,TFØRM,STURM,PREP,QSVEC,DAGGER,ANDD
SEG DET*,(SWCH)
IN DETERM,DET2,DCØMP2,SUPER
SEG BCV*,(SWCH)
IN BCVECT
SEG INI*,(RØØT)
IN INITAL
SEG LEB*,(RØØT)
IN LEBEGE,FIXEM,TØBAR,TEMØEG,PLYNE,PLYCØ
SEG ØD1*,(LEB)
IN ØDE1
SEG ØD2*,(LEB)
IN ØDE2
SEG TRAP*,(RØØT)
IN ETRAP
```

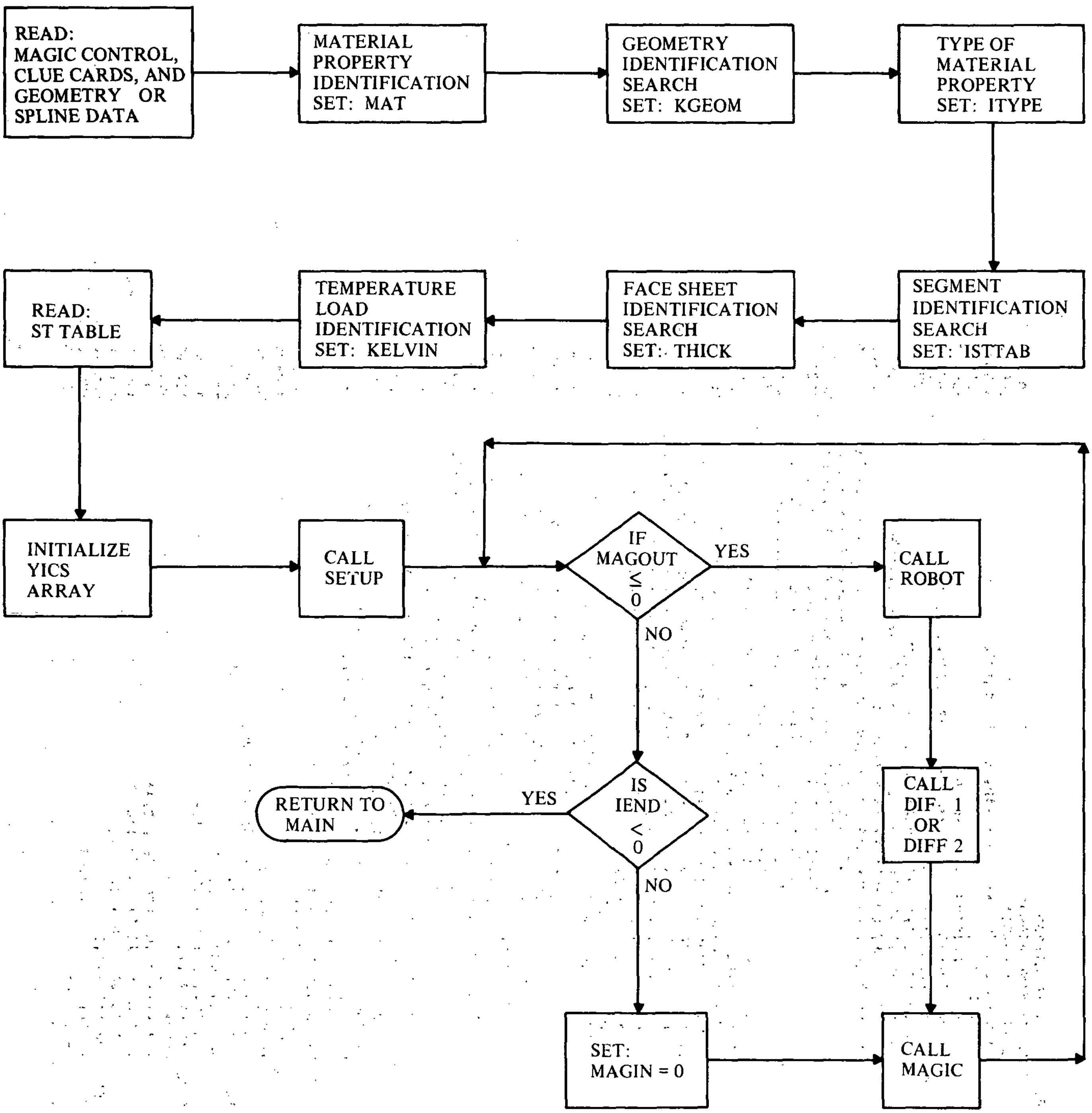
SUBROUTINE RIEMAN

This subroutine link assembles the data tables for use in the integration procedure. The program has the capability of handling two loading conditions (due to rotation or static prestress). Temperature load can be included in the static prestress.

The subprogram link, RIEMAN, utilizes the subroutines SETUP, ROBOT, DIF1, or DIFF2, to integrate the differential equations of each segment independently, under arbitrary load conditions. The results of the integrations of each segment are stored in the YCORR array in RIEMAN, and represent the stiffness and deflection coefficients of each segment.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
XFTHLD	f_θ
XFPHLD	f_ϕ
XFZELD	f_ζ
XMTHLD	m_θ
XMPHLD	m_ϕ
ETHET	E_θ
EPHI	E_ϕ
XGPT	$G_{\phi\theta}$
XNUTP	$\nu_{\theta\phi}$
XNUPT	$\nu_{\phi\theta}$
ALPHTH	α_θ
ALPHPH	α_ϕ
XNTTH	$N_{T\theta}$
XNTPH	$N_{T\phi}$
XMTTH	$M_{T\theta}$
XMTPH	$M_{T\phi}$
XK11	K_{11}
XK22	K_{22}
XD11	D_{11}
XD22	D_{22}
XK33	K_{33}
XD33	D_{33}

RIEMAN



READ: MAGIC CONTROL, CLUE CARDS, AND GEOMETRY OR SPLINE DATA
MATERIAL PROPERTY IDENTIFICATION SET: MAT
GEOMETRY IDENTIFICATION SEARCH SET: KGEOM
TYPE OF MATERIAL PROPERTY SET: ITYPE
SEGMENT IDENTIFICATION SEARCH SET: ISTTAB
FACE SHEET IDENTIFICATION SEARCH SET: THICK
TEMPERATURE LOAD IDENTIFICATION SET: KELVIN
READ: ST TABLE
INITIALIZE YICS ARRAY
CALL SETUP
IF MAGOUT ≤ 0
YES
NO
CALL ROBOT
CALL DIF 1 OR DIFF 2
IS IEND < 0
YES
NO
RETURN TO MAIN
SET: MAGIN = 0
CALL MAGIC

```
FØR,IS RIEMAN,RIEMAN
      SUBRØUTINE RIEMAN
      SQRT(X) = DSQRT(X)
      INTEGER SAVJTC,SAVSTP,SEGTAB, Q ,THICK,TYPE
      INTEGER XN
      DØUBLE  PRECISIØN  YNEW,YPRED
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YCØRR
      DØUBLE PRECISIØN ARG,ERR,DIFF,DTAU,STEP,TIME
      DØUBLE PRECISIØN DELTA,DTIME,EPSIL,XSAVE2,XSAVE3,XSAVE4
      DØUBLE PRECISIØN YDEV,YICS,TBDEL,FWDEL
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ,
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,
     6                 XD11,XNPHI,BETA,XC16
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS, N1,KBC,NRINGS
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)
      CØMMØN /LYCØRR/ YCØRR(80)
      CØMMØN /MAGIK/ KKNT
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),
     1                YANTH,YAMTH,YAMPT,YAJPH,
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3                X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5    RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),DUM,
     8                XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9                XK11,XK12,XK21,XK22,XK33,XD11,
     A                XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /SPLINS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1       DR1DP(100),ZI(14),RI(14),NRZIN
      CØMMØN /ARING/ NRING(28),AMAT(30,4)
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      DIMENSIØN LST(13),YDEV(80),YICS(80),YNEW(80)
      DIMENSIØN TBDEL(80),FWDEL(80)
      DIMENSIØN ST(72,31), XLAYER(10)
      DIMENSIØN TMPAV(5)
 1726 FØRMAT(1H1)
      IF(Q.EQ.1)  GØ TØ 191
      READ(5,1C01,END=9998) RGØ,ANG,STØRY
 1001 FØRMAT(F2.0,A1,16A4)
      WRITE(1) RGØ,ANG,STØRY
      READ(5,1C02) DTAU,DIFF,STEP
 1002 FØRMAT(3D14.1)
      DELTA = C.DO
      WRITE(1) DTAU,DIFF,STEP,DELTA
      IF (RGØ.EQ.14.0) GØ TØ 180
      READ(5,1C06) G1,G2,G3
 1006 FØRMAT(3E14.1)
      WRITE(1)      G1,G2,G3
      GØ TØ 481
```

```
 180 READ(5,198) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
 198 FØRMAT(I2,7F10.0/7F10.0)
     WRITE(1) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
 481 CØNTINUE
     READ(5,1003) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
1003 FØRMAT(5(A4,6X),E10.1,10X,I2)
     IF(NP.LT.2.ØR.NP.GT.30) GØ TØ 8787
     WRITE(1) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
     GØ TØ 192
 191 READ(1) RGØ,ANG,STØRY
     READ(1) DTAU,DIFF,STEP,DELTA
     IF (RGØ.EQ.14.0) GØ TØ 182
     READ (1      ) G1,G2,G3
     GØ TØ 183
 182 READ(1) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
 183 CØNTINUE
     READ(1) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
 192 EPSIL =1.0E-05
     DIFF  =1.0E-04
     ERR = 1.0 E-07
     I = RGØ
     IF (NH.NE.0) GØ TØ 920
     WRITE(6,651) NSC,I,STØRY,DTAU,DIFF,STEP,DELTA
 651 FØRMAT(//13X,15HSEGMENT NUMBER ,I2,5X,13HSEGMENT CØDE ,I2,5X,
    1   16A4//22X,4HDTAU,15X,4HDIFF
    2,15X,4HSTEP,10X,5HDELTA//16X,5(E14.7,5X),2X,F2.0)
     IF (RGØ.EQ.14.0) GØ TØ 185
     WRITE(6,652)  G1,G2,G3
 652 FØRMAT(//54X,24HGEØMETRY INPUT VARIABLES,//38X,3(E14.7,5X))
     GØ TØ 645
 185 WRITE(6,186) (ZI(I),RI(I),I=1,NRZIN)
 186 FØRMAT(//57X,24HGEØMETRY INPUT VARIABLES//42X,16HAXIAL CØØRDINATE,
    1        9X,6HRADIUS/50X,1HZ,20X,1HR/(43X,1P1E15.8,5X,1P1E15.8))
 645 WRITE(6,653) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
 653 FØRMAT(//12X,5(A4,6X),9HT FREE = ,E10.3,12X,
    1        26HNUMBER ØF TABLE CØLUMNS = ,I2)
 920 CØNTINUE
C    MATERIAL PRØPERTY IDENTIFICATIØN
     DØ 501 I=1,NMPT
     IF (HLAYR-STD(I)) 501,502,501
 502 MAT=I
     GØTØ 503
 501 CØNTINUE
     GØTØ 8036
C    GEØMETRY IDENTIFICATIØN SEARCH
 503 DØ 504 I = 1,7
     IF(RGØ-STRGØ(I)) 504,505,504
 504 CØNTINUE
     GØTØ 8086
 505 KGEØM=I
     DØ 506 I=1,3
     IF(TYPE-MATER(I))506,507,506
 506 CØNTINUE
     GØTØ 8087
 507 ITYPE=I
     DØ 510 I=1,12
     IF(INTERP-SEGTAB(I))510,511,510
 510 CØNTINUE
     GØ TØ 8088
 511 ISTTAB=I
     DØ 508 I=1,4
```

```
      IF (SHEET-FACE(I)) 508,5C9,508
  508 CØNTINUE                                                          301260
      GØTØ 8089                                                         301270
  509 THICK=I                                                           301280
      KLUE2=1                                                           301290
      GØ TØ (430,430,420,420,420,420,425,425,425, 430,430,430),ISTTAB  301300
  420 KLUE2=2                                                           301310
      GØ TØ 430                                                         301320
  425 KLUE2=3                                                           301330
  430 KLUE1=THICK                                                       301340
C     TEMPERATURE LØAD IDENTIFICATIØN                                   301350
      DØ 401 I=1,4                                                      3C1360
      IF(RANKIN.EQ.THERM(I))GØTØ 402                                    301370
  401 CØNTINUE                                                          301380
      GØTØ 8090                                                         301390
  402 KELVIN=I                                                          3C1400
C     LINEAR ANALYSIS IDENTIFICATIØN                                    301410
      IANLYZ = 1                                                        301420
      NRØW = 3                                                          301430
      IF (THICK.GT.1) NRØW = THICK+3                                    301440
      IF (ISTTAB.EQ.1) NRØW = 17                                        301450
      IF (ISTTAB.EQ.3) NRØW = 19                                        301460
      IF (ISTTAB.EQ.4) NRØW = 10                                        301470
      IF (ISTTAB.EQ.5) NRØW = 12                                        301480
      IF (ISTTAB.EQ.6) NRØW = 13                                        301490
      IF (ISTTAB.EQ.7) NRØW = 9                                         301500
      IF (ISTTAB.EQ.8) NRØW = 11                                        301510
      IF (ISTTAB.EQ.9) NRØW = 12                                        301520
      IF (ISTTAB.EQ.10) NRØW = 15                                       301530
      IF (ISTTAB.EQ.11) NRØW = 17                                       301540
      IF (ISTTAB.EQ.12) NRØW = 18                                       301550
      NCØNT = NRØW                                                      3C1560
      L= 2*(MAT-1)+1                                                    301570
      II=NXMAT(L)                                                       301580
      III=NXMAT(L+1)                                                    3C1590
      IF (NH.NE.0) GØ TØ 921                                            301600
      WRITE(6,654)  ((XMAT(I,J),J=1,10),I=II,III)                       301610
  654 FØRMAT(//51X,28HMATERIAL PRØPERTY TABLE USED,//(10(1H ,E12.5)))   301620
      WRITE(6,655)                                                      3C1630
  655 FØRMAT(//42X, 47HTABLE ØRDER PHI ØR S VS. CRØSSECTIØN PRØPERTIES,) 301640
  921 CØNTINUE                                                          301650
       DØ 901  I=1,NRØW                                                 301660
      IF(Q.EQ.1)  GØ TØ 193                                             3C1670
      READ (5,1005) (ST(I,J),J=1,NP)                                    301680
 1005 FØRMAT (5E14.7)                                                   301690
      WRITE(1)        (ST(I,J),J=1,NP)                                  301700
      IF (NH.NE.0) GØ TØ 901                                            301710
  194 WRITE(6,600) (ST(I,J),J=1,NP)                                     301720
  600 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))                          301730
      GØ TØ 901                                                         301740
  193 READ (1       ) (ST(I,J),J=1,NP)                                  301750
  901 CØNTINUE                                                          301760
      DØ 750 JJ=1,12                                                    301770
  750 LST(JJ) = 0                                                       301780
      NLCS = NLCASE                                                     301781
      IF (IWØRD.GE.3) NLCS = NLCASE-1                                   301782
      IF (NLCS.LE.0) GØ TØ 590                                          301790
      K=NRØW+1                                                          3C1800
      JJ=1                                                              301810
      JJJ=6                                                             301820
      MM=1                                                              301830
```

```
      DØ 17 NLC=1,NLCS
      JT = JJ
      JTT= JJJ
      L=0
      IF(Q.EQ.1)  GØ TØ 195
      READ(5,1004) (LST(J),J=JJ,JJJ)
 1004 FØRMAT(6I1)
      WRITE(1) (LST(J),J=JJ,JJJ)
      GØ TØ 196
  195 READ(1) (LST(J),J=JJ,JJJ)
  196 CØNTINUE
      IF(LST(JJ))8031,19,20
   20 L = LST(JJ)
      IF (NLC.GT.1.AND.LST(1).NE.0.AND.LST(JT).NE.0) GØ TØ 8008
   19 JJ=JJ+1
   23 IF(LST(JJ))8031,22,21
   21 L=L+1
   22 IF(JJ.EQ.JJJ) GØTØ 24
      JJ=JJ+1
      GØTØ 23
   24 IF(L.EQ.0) GØ TØ 71
      KK = K + L - 1
      DØ 72 M=K,KK
      IF(Q.EQ.1)  GØ TØ 197
      READ (5,1005) (ST(M,J),J=1,NP)
      WRITE(1)      (ST(M,J),J=1,NP)
      GØ TØ 72
  197 READ (1     ) (ST(M,J),J=1,NP)
   72 CØNTINUE
      IF (LST(JT).EQ.0) GØ TØ 660
      LY = K
      KY = K
      KZ = K+LST(1)-1
      K = KZ+1
      IF (NH.NE.0) GØ TØ 665
      WRITE(6,656)
  656 FØRMAT(//45X,42HTABLE ØRDER PHI ØR S VS. TEMPERATURE LØADS,)
      DØ 657 N=KY,KZ
      WRITE(6,600) (ST(N,J),J=1,NP)
  657 CØNTINUE
  660 IF((L-LST(JT)).EQ.0) GØ TØ 665
      IF (NH.NE.0) GØ TØ 665
      WRITE(6,661) NLC
  661 FØRMAT(//16X,8HPRØBLEM ,I2,5X,84HTABLE ØRDER  PHI ØR S VS. DISTRIB
     1UTED LØADS (F THETA, F PHI, F ZETA, M THETA, M PHI),)
      WRITE(6,1968) (LST(J),J=JT,JTT)
 1968 FØRMAT(27H LØAD IDENTIFICATIØN CLUES ,6I1/)
      DØ 662 N = K, KK
      WRITE(6,600) (ST(N,J),J=1,NP)
  662 CØNTINUE
  665 CØNTINUE
   71 K = K + L - LST(JT)
      JJ=JJJ+1
      JJJ=JJ+5
   17 MM=MM+1
  590 CØNTINUE
      IF (Q.EQ.1) GØ TØ 2004
      READ (5,591) IS,SAVJTC(IS),SAVSTP(IS),(STØRY(I),I=1,16)
  591 FØRMAT (3I5,16A4)
      READ(5,2000)
 2000 FØRMAT(1X)
```

```
      WRITE(1) IS,SAVJTC(IS),SAVSTP(IS),STØRY
      GØ TØ 2005
 2004 READ(1) IS,SAVJTC(IS),SAVSTP(IS),STØRY
 2005 CØNTINUE
      ITIC = SAVJTC(IS)
      ISTØP = SAVSTP(IS)
      JTIC = JRTIC(NRC)
      JSTØP = JRSTØP(NRC)
      TIC = ST(1,1)
      STØP = ST(1,NP)
      NEQNS=64+8*NPRØB
      DØ 73 I=1,NEQNS
   73 YICS(I)=C.0
      YICS(5) =1.0
      YICS(14)=1.0
      YICS(23)=1.0
      YICS(32)=1.0
      YICS(33)=1.0
      YICS(42)=1.0
      YICS(51)=1.0
      YICS(60)=1.0
      NCYC=0
      NSAVE=NRØW
      IEND=0
      PRINT=TIC
      DTA=DTAU
      DTAU = 0.D0
      IF (NH.NE.0.AND.NLCASE.NE.0) READ(13) SAVY
 2001 FØRMAT(1X,1P1E16.7,I5,1P6E16.7)
   59 CALL SETUP (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,
     1DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)
      GØTØ  61
   60 CALL MAGIC (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,
     1 DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)
   61 IF(MAGØUT.LE.0) GØTØ 25
      IF(TIME.GT.STØP) GØTØ 62
      IF(TIME.LT.STØP) GØTØ 63
   64 IEND=-1
      GØTØ 67
   62 IF(TIME.LE.(STØP+DIFF)) GØTØ 64
      GØTØ 8001
   63 IF((STØP-DIFF).LE.TIME) GØTØ 64
      IF((TIME+DTIME).GT.STØP) GØTØ 65
      IF(PRINT.GT.TIME) GØTØ 66
      PRINT=TIME+DTA
   67 CØNTINUE
      IF(IEND.GT.0) GØTØ 8002
      IF(IEND.LT.0) GØTØ  150
   66 CØNTINUE
      MAGIN = 0
      GØTØ 60
   65 DTIME=STØP-TIME
      DELTA = 0.D0
      GØTØ 67
   75 NCYC=NCYC+1
      MAGIN=-1
      GØTØ 60
   25 LT=0
      IF (NH.NE.0.AND.KKNT.EQ.4.AND.NLCASE.NE.0) READ(13) SAVY
      JJ = NLCASE*6
      DØ 15  J=1,JJ
```

```
   15 LT=LT+LST(J)
  296 NTØTAL = LT+NSAVE
      PHI=TIME
      ARG=PHI
      LL=NP+1
      DØ 51 I=1,NP
      IF(ARG-ST(1,I)) 52,55,51
   52 IF(I-1) 55,55,54
   51 CØNTINUE
      I=NP
      GØ TØ 55
   54 DØ 57 IK=2,NTØTAL
   57 ST(IK,LL)=ST(IK,I-1)+(ST(IK,I)-ST(IK,I-1))*(ARG-ST(1,I-1))/(ST(1,I
     1)-ST(1,I-1))
      GØTØ 80
   55 DØ 58 IK=2,NTØTAL
   58 ST(IK,LL)=ST(IK,I)
   80 CØNTINUE
C     THE UPDATED INTERPØLATED VALUES ØF THE MATERIAL PRØPERTY CØEFFIC
C     IENTS ARE FØUND IN THE XMAT TABLE AND STØRED IN THE XLAYER ARRAY
      L = (MAT-1)*2+1
      II=NXMAT(L)
       III=NXMAT(L+1)
      LL=NP+1
      L=NRØW + 1
      IF(KELVIN .NE. 1)GØ TØ 81
      IF(THICK.NE.1)GØ TØ 83
   81 LØØP=1
      ILØW=1
      IHIGH = 1
      IF(KELVIN .NE. 1)GØ TØ 85
   82 CØNTINUE
      TMPAV(ILØW)=(ST(L,LL)+ ST(L+1,LL)+ ST(L+2,LL) + ST(L+3,LL))/4.0
      GØ TØ 85
   83 LØØP = 2
      ILØW= 1
      IHIGH = 2
      TMPAV(ILØW)= (ST(L,LL)+ ST(L+1,LL))/2.0
      TMPAV(IHIGH)=(ST(L+2,LL) + ST(L+3,LL))/2.0
   85 DØ 105 IL=ILØW,IHIGH
      M=1
      GØTØ (91,92,93,93),KELVIN
   91 ARG= TMPAV(IL)
      GØTØ 94
   93 CØNTINUE
      ARG = ST(NRØW+1,LL)
      TMPAV(1) = ARG
   94 DØ 104 I = 2,10
      IF (ARG-XMAT(II,I)) 121,123,104
  121 IF (I-2) 8007,8007,124
  104 CØNTINUE
      GØTØ 8067
  123 L=II+1
      DØ 122 J=L,III
      XLAYER(M)=XMAT(J,I)
  122 M=M+1
      GØTØ 111
  124 L=II+1
      DØ 125 J=L,III
      XLAYER(M)=XMAT(J,I-1)+(XMAT(J,I)-XMAT(J,I-1))*(ARG-XMAT(II,I-1))/
     1          (XMAT(II,I)-XMAT(II,I-1))
```

```
125 M=M+1
    GØTØ 111
 92 L = II + 1
    DØ 922  J=L,III
    XLAYER(M)= XMAT(J,1)
922 M=M+1
111 GØ TØ (115,115,112,113,114),LØØP
112 XNUTP= XLAYER(2)
    IF(ITYPE.NE. 1)GØ TØ 131
    XNUPT= XNUTP
    XGPT(1) = ETHET(1)/(2*(1+ XNUPT))
    XGPT(2) = ETHET(2)/(2*(1+ XNUPT))
    GØ TØ 106
131 XNUTP = XLAYER(3)
    XNUPT = ETHET(1)*XNUTP/EPHI(1)
    GØ TØ 106
113 ES= XLAYER(8)
    ALPHS=XLAYER(10)
    GØ TØ 106
114 ALPHR = XLAYER(9)
    ER = XLAYER(7)
    GØ TØ 118
115 GØ TØ(101,102,103),ITYPE
101 ETHET(IL)= XLAYER(1)
    XNUTP = XLAYER(2)
    ALPHTH(IL)= XLAYER(3)
    EPHI(IL) = ETHET(IL)
    XNUPT= XNUTP
    ALPHPH(IL)= ALPHTH(IL)
    XGPT(IL)= ETHET(IL)/(2.0*(1.0+ XNUPT))
    GØ TØ 105
102 ETHET(IL)= XLAYER(1)
    EPHI(IL) = XLAYER(2)
    XNUTP = XLAYER(3)
    ALPHTH(IL)= XLAYER(4)
    ALPHPH(IL)= XLAYER(5)
    XGPT(IL) = XLAYER(6)
    XNUPT= ETHET(IL)* XNUTP/EPHI(IL)
    GØ TØ 105
    EPHI(IL)= XLAYER(2)
    XNUTP= XLAYER(3)
103 ETHET(IL)= XLAYER(1)
    ALPHTH(IL) = XLAYER(4)
    ALPHPH(IL) = XLAYER(5)
    XGPT(IL) = XLAYER(6)
    ER= XLAYER(7)
    ES =XLAYER(8)
    ALPHR = XLAYER(9)
    ALPHS = XLAYER(10)
    XNUPT = ETHET(IL) * XNUTP/EPHI(IL)
105 CØNTINUE
106 L = NRØW+1
    GØ TØ (117,107,108,119,118),LØØP
107 LØØP= 3
    ILØW = 3
    IHIGH= 3
    GØ TØ 82
108 IF(ITYPE .EQ.3 .AND. ISTTAB .GE. 3)GØ TØ 109
    GØ TØ 118
109 LØØP= 4
    ILØW =4
```

```
      IHIGH = 4                                                        304320
      CPH = ST(3,LL)                                                   304330
      IF(ISTTAB.GE. 10.AND. ISTTAB.LE. 12)CPH = ST(6,LL)               304340
      IF(CPH     .LE.0)GØ TØ 281                                       304350
      TMPAV(4)= ST(L,LL)                                               304360
      GØ TØ 85                                                         304370
  281 TMPAV(4) =ST(L+3,LL)                                             304380
      GØ TØ 85                                                         304390
  119 LØØP=5                                                           304400
      ILØW=5                                                           304410
      IHIGH=5                                                          304420
      CTH = ST(3,LL)                                                   304430
      IF(ISTTAB.GE. 10.AND. ISTTAB.LE. 12)CTH = ST(7,LL)               304440
      IF(CTH     .LE. 0)GØ TØ 116                                      304450
      TMPAV(5)= ST(L,LL)                                               304460
      GØ TØ 85                                                         304470
  116 TMPAV(5)= ST(L+3,LL)                                             30448C
      GØ TØ 85                                                         304490
  117 CØNTINUE                                                         304500
      ETHET(2)= ETHET(1)                                               304510
      ALPHTH(2)=ALPHTH(1)                                              304520
      ALPHPH(2)=ALPHPH(1)                                              304530
      XGPT(2)= XGPT(1)                                                 304540
      EPHI(2)= EPHI(1)                                                 304550
  118 CØNTINUE                                                         304560
      CALL RØBØT(ST,KLUE2,NRØW,LL,ER,ES,G2,G3,TIME,ITIC,JTIC,NCYC,NCØNT) 304580
      IF (NIX.NE.0) GØ TØ 9999                                         304610
C     CØMPUTATIØN ØF K AND D FØR K AND D INPUT                         304620
      LL=NP+1                                                          304630
      IF(XK11.EQ.0.0) GØTØ 8101                                        304640
      IF(ITYPE.EQ.3.AND.XK12.EQ.0.) GØ TØ 8102                         304650
      IF(ITYPE.EQ.3.AND.XK21.EQ.0.) GØ TØ 8103                         304660
      IF(XK22.EQ.0.0) GØTØ 8104                                        304670
      IF(XK33.EQ.0.0) GØTØ 8105                                        304680
      IF(XD11.EQ.0.0) GØTØ 8106                                        304690
      IF(ITYPE.EQ.3.AND.XD12.EQ.0.) GØ TØ 8107                         304700
      IF(ITYPE.EQ.3.AND.XD21.EQ.0.) GØ TØ 8108                         304710
      IF(XD22.EQ.0.0) GØTØ 8109                                        304720
      IF(XD33.EQ.0.0) GØTØ 811C                                        304730
      NL=0                                                             304740
      XSAVE1 = XNTTH                                                   304750
      XSAVE2 = XNTPH                                                   304760
      XSAVE3 = XMTTH                                                   30477C
      XSAVE4 = XMTPH                                                   304780
      XNTTH = 0.0                                                      304790
      XNTPH = C.0                                                      304800
      XMTTH = C.0                                                      304810
      XMTPH = C.0                                                      304820
      XFTHLD=C.0                                                       304830
      XFPHLD=0.0                                                       304840
      XFZELD=C.0                                                       304850
      XMTHLD=0.0                                                       304860
      XMPHLD=0.0                                                       304870
      JF=8+NPRØB                                                       304880
      K = NRØW                                                         30489C
      NLCSE = NLCASE                                                   304900
      IF (NH.EQ.0) NLCSE = 1                                           304910
      XFPHL1 = 0.0                                                     304920
      XFZEL1 = C.0                                                     304930
      XFPHL2 = 0.0                                                     304940
      XFZEL2 = 0.0                                                     304950
```

```
C     ANALYS=LINE
C     ANALYS=ØMTH
C     ANALYS=NPH
      XNPHI= 0.0
      DØ 77 M=1, JF
      I = (M-1)*8 + 1
      IF (I.EQ.1.AND.NH.NE.0) GØ TØ 252
      IF (M.LT.9) GØTØ    49
      XNTTH = XSAVE1
      XNTPH = XSAVE2
      XMTTH = XSAVE3
      XMTPH = XSAVE4
  252 DØ 250 JKL=1,NLCSE
      IF (JKL.EQ.2.ØR.M.EQ.10.ØR.IWØRD.EQ.3.ØR.IWØRD.EQ.5) GØ TØ 148
      NL=NL+1
      IR=NL*6-5
      IF(LST(IR).NE.0) K=K+LST(IR)
      IF (LST(IR+1).EQ.0) GØTØ 44
      K=K+1
      XFTHLD=ST(K,LL)
   44 IF(LST(IR+2).EQ.0) GØTØ 45
      K=K+1
      XFPHLD=ST(K,LL)
   45 IF(LST(IR+3).EQ.0) GØTØ 46
      K=K+1
      XFZELD=ST(K,LL)
   46 IF(LST(IR+4).EQ.0) GØTØ 47
      K=K+1
      XMTHLD=ST(K,LL)
   47 IF(LST(IR+5).EQ.0) GØTØ 48
      K=K+1
      XMPHLD=ST(K,LL)
   48 CØNTINUE
      GØ TØ 149
  148 XFTHLD = 0.0
      XFPHLD = XMERD
      XFZELD = XPRES
      XMTHLD = XMØNT
      XMPHLD = 0.0
  149 CØNTINUE
      IF (JKL.EQ.2) GØ TØ 251
      XFPHL1 = XFPHLD
      XFZEL1 = XFZELD
  251 XFPHL2 = XFPHLD
      XFZEL2 = XFZELD
  250 CØNTINUE
   49 IF(ISTTAB.GE.3.AND.ISTTAB.LE.9)GØ TØ 4002
      CALL DIF1 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      GØ TØ 77
 4002 CALL DIFF2 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
   77 CØNTINUE
      GØTØ 75
 8001 IERRØR=8001
      NERRØR=11
      GØTØ 8888
 8002 IERRØR=8002
      NERRØR=12
      GØTØ 8888
 8007 IERRØR=8007
      NERRØR=15
      GØTØ 8888
```

```
8008 IERRØR = 8008
     NERRØR=10
     GØ TØ 8888
8C31 IERRØR=8C31
     NERRØR= 9
     GØTØ 8888
8036 IERRØK=8C36
     NERRØR= 2
     GØTØ 8888
8086 IERRØR=8086
     NERRØR= 3
     GØTØ 8888
8087 IERRØR=8087
     NERRØR= 4
     GØTØ 8888
8088 IERRØR=8C88
     NERRØR=27
     GØTØ 8888
8089 IERRØR=8C89
     NERRØR= 5
     GØTØ 8888
8090 IERRØR=8C90
     NERRØR= 6
     GØTØ 8888
8067 IERRØR= 8067
     NERRØR=16
     GØTØ 8888
8101 IERRØR = 8101
     NERRØR=17
     GØTØ 8888
8102 IERRØR = 8102
     NERRØR=18
     GØTØ 8888
8103 IERRØR = 8103
     NERRØR=19
     GØTØ 8888
8104 IERRØR = 8104
     NERRØR=2C
     GØTØ 8888
8105 IERRØR = 8105
     NERRØR=21
     GØTØ 8888
8106 IERRØR = 8106
     NERRØR=22
     GØTØ 8888
8107 IERRØR = 8107
     NERRØR=23
     GØTØ 8888
8108 IERRØR = 8108
     NERRØR=24
     GØTØ 8888
8109 IERRØR = 8109
     NERRØR=25
     GØTØ 8888
8110 IERRØR = 8110
     NERRØR=26
     GØTØ 8888
8787 IERRØR = 8787
     NERRØR=34
8888 NIX=1
     RETURN
```

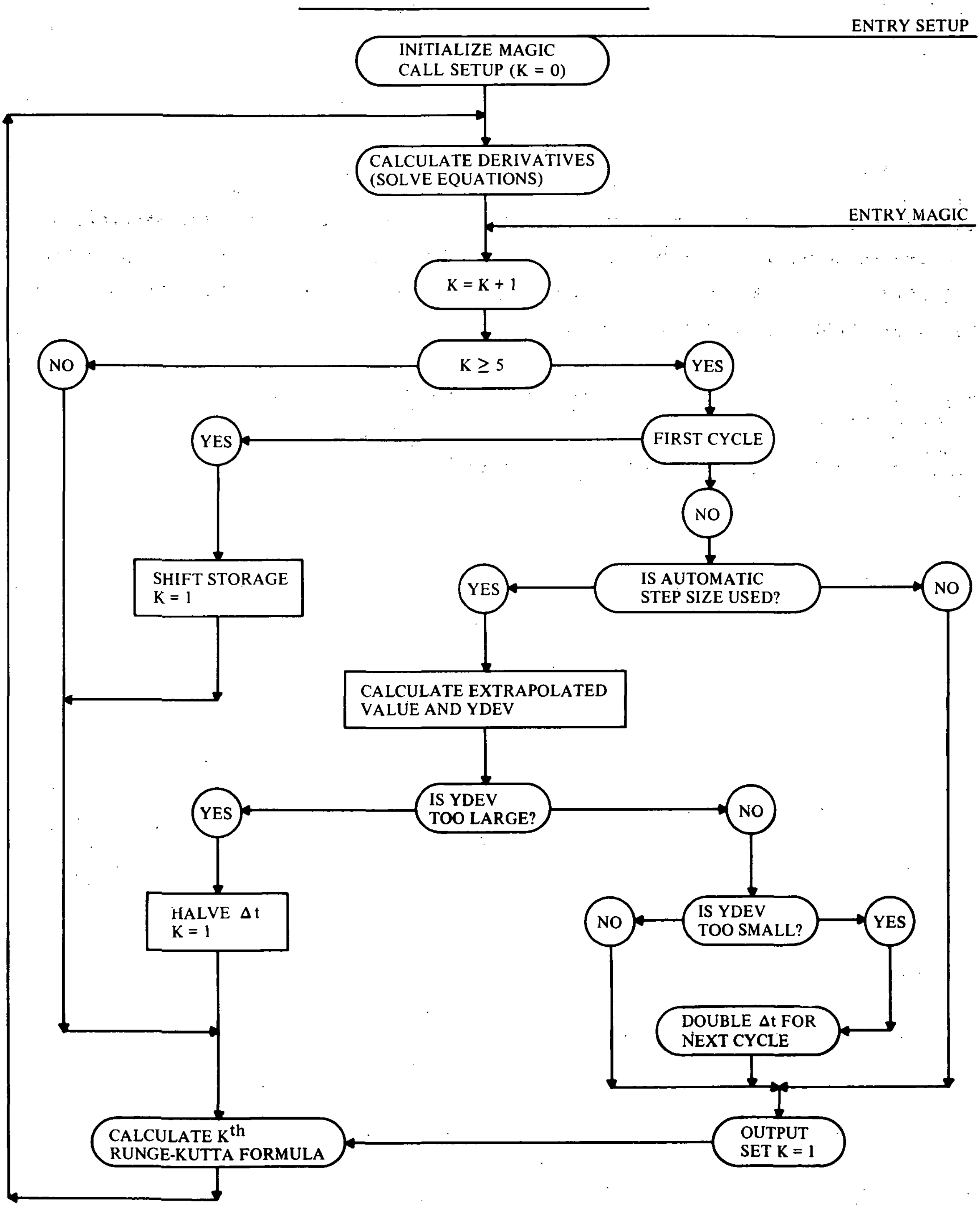
```
 150 CØNTINUE                                                            306180
     IF (NH.NE.0) GØ TØ 925                                              306220
     WRITE(6,670)                                                        306250
 670 FØRMAT(//46X,41HMATRIX X AND Y (TRANSPØSED)  MAGIC ØUTPUT)          306260
     WRITE(6,672)  (YCØRR(I),I=1,NEQNS)                                  306270
 672 FØRMAT(8(2X,E14.7))                                                 306280
 925 CØNTINUE                                                            306290
     RESTØP=RØ                                                           306300
     RADUS(ISTØP) = RØ                                                   306310
     TADUS(ISTØP)=RØ                                                     306320
     AMAT(ISTØP,1) = SAVY(7)                                             306350
     AMAT(ISTØP,2) = SAVY(8)                                             306360
     IF(NSC.LT.NSEG) GØ TØ 9999                                          306350
     SADUS(JSTØP) = RØ                                                   306360
     UADUS(JSTØP)=RØ                                                     306370
     AMAT(JSTØP,3) = SAVY(7)                                             306400
     AMAT(JSTØP,4) = SAVY(8)                                             306410
     IF(ITIC.LE.ISTØP) GØ TØ 9999                                        306400
     SADUS(JSTØP)=RADUS(ITIC)                                            306410
     UADUS(JSTØP)=RADUS(ITIC)                                            306420
9999 CØNTINUE
     RETURN                                                              306460
9998 WRITE(6,9997)                                                       306470
9997 FØRMAT(-THE PRØGRAM HAS PRØCESSED ALL THE DATA FØR A CHAIN ØF UNCØ  306480
    1UPLED SEGMENTS-)                                                    306490
     STØP                                                                306500
      END                                                                306510
```

SUBROUTINE SETUP

SETUP is a double entry subroutine called from RIEMAN. It is a mixed precision, numerical integration routine, with automatic selection of a variable integration step size, which utilizes fifth order Runge-Kutta equations to obtain the solution for first order differential equations.

SUBROUTINE MAGIC

MAGIC is an alternate entry point to subroutine SETUP.


ENTRY SETUP
INITIALIZE MAGIC
CALL SETUP (K = 0)
CALCULATE DERIVATIVES
(SOLVE EQUATIONS)
ENTRY MAGIC
K = K + 1
NO
K ≥ 5
YES
YES
FIRST CYCLE
NO
SHIFT STORAGE
K = 1
YES
IS AUTOMATIC
STEP SIZE USED?
NO
CALCULATE EXTRAPOLATED
VALUE AND YDEV
YES
IS YDEV
TOO LARGE?
NO
HALVE Δt
K = 1
NO
IS YDEV
TOO SMALL?
YES
DOUBLE Δt FOR
NEXT CYCLE
CALCULATE K^th
RUNGE-KUTTA FORMULA
OUTPUT
SET K = 1

SUBROUTINE ROBOT

This subroutine is used by RIEMAN to calculate geometric and load coefficients for use in the differential equations. With reference to geometry, all the necessary radii are calculated, as well as the stiffness coefficients of the various shell wall constructions. Thermal load moments and direct forces are also calculated from direct temperature input. Loads due to rotation, and the shell wall areal mass are also calculated by ROBOT.

All the above values are passed back via the label common area EQUAZN.

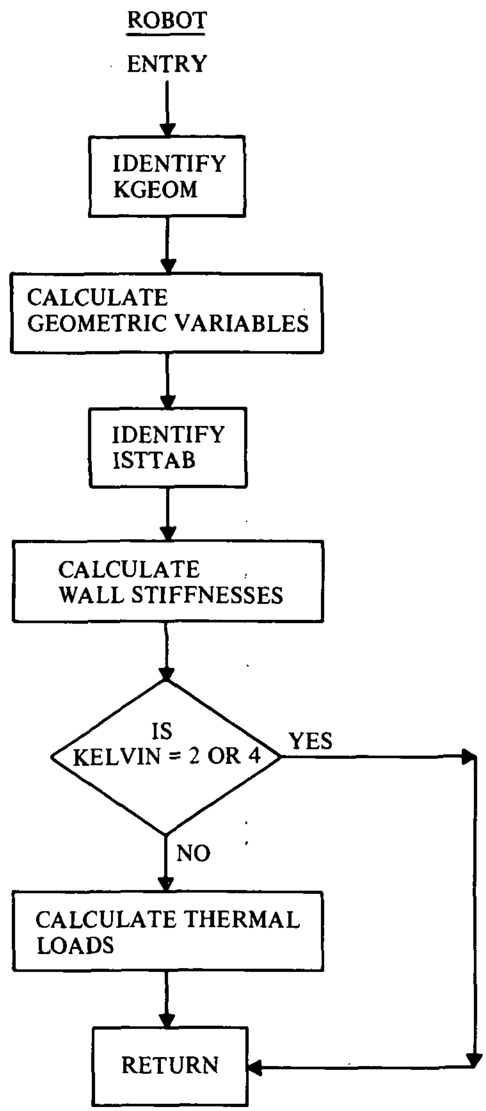
In the case of a special point input geometry the ROBOT routine calls GEOMET.

Subroutines GEOMET, PLICO, PLINE

Starting from a set of z, r points these subroutines calculate the necessary radii of the shell curves using spline fits.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
RO	r_0
R1	r_1
R1DOT	$r_{1,\phi}$
CS	$\cos \phi$
SN	$\sin \phi$
A	a
C	c
XN	n
F2	f_2
F3	f_3
TAN; TN	$\tan \phi$
SEC	$\sec \phi$
TII	T_{ii}
TIK	T_{ic}
TOK	T_{oc}
TOO	T_{oo}
TEFREE	$\overline{T}$
HI	h_i
HO	h_o
T	t
TI	t_i
TO	t_o
SNSQ	$\sin^2\phi$
CSSQ	$\cos^2\phi$
CN	$\cos \phi \sin \phi$
X1CS	$1/\cos \phi$
X1SN	$1/\sin \phi$
R2	r_2
BETA	β

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
X1ROSN	$1/r_0 \sin \phi$
X1ROCS	$1/r_0 \cos \phi$
CSX1RO	$\cos \phi/r_0$
CSX1R1	$\cos \phi/r_1$
CSX1R2	$\cos \phi/r_2$
SNX1RO	$\sin \phi/r_0$
SNX1R1	$\sin \phi/r_1$
X1R1	$1/r_1$
X1R2	$1/r_2$
X1R1SQ	$1/r_1^{\ 2}$
X1ROSQ	$1/r_0^{\ 2}$


ROBOT
ENTRY
IDENTIFY KGEOM
CALCULATE GEOMETRIC VARIABLES
IDENTIFY ISTTAB
CALCULATE WALL STIFFNESSES
IS KELVIN = 2 OR 4
YES
NO
CALCULATE THERMAL LOADS
RETURN

```
FØR,IS RØBØT,RØBØT
      SUBRØUTINE RØBØT (ST,KLUE2,NRØW,LL,ER,ES,G2,G3,TIME,ITIC,JTIC,        2500010
     1                  NCYC,NCØNT)                                        2500020
      INTEGER SAVJTC,SAVSTP,Q,THICK                                        2500030
      INTEGER XN1,XN2,XN                                                   2500040
      REAL*4 I2                                                            2500050
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                    2500060
      DØUBLE PRECISIØN TEMP1,TEMP2,TEMP3,TEMP4,TEMP5,TEMP8,TEMP10,TEMP11 2500070
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ, 2500080
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,   2500090
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,    2500100
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,      2500110
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,      2500120
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,      2500130
     6                XD11,XNPHI,BETA,XC16                                2500140
      DØUBLE PRECISIØN YPRED,TIME                                          2500150
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)            2500160
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                               2500170
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH              2500180
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)     2500190
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB    2500200
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE    2500210
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS               2500220
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),YANTH,YAMTH,           2500230
     1        YAMPT,YAJPH,S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,       2500240
     2        X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,       2500250
     3        CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,BETA,R1,     2500260
     4        R2,S1,R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,    2500270
     5        XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),            2500280
     5        ALPHPH(2),DUM,XNUTP,XNUPT,                                   2500290
     6        XC11,XC22,XC15,XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,      2500300
     7        XK33,XD11,XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16                 2500310
      CØMMØN /SPLINS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),           2500320
     1       DR1DP(100),ZI(14),RI(14),NRZIN                                2500330
      CØMMØN /ARING/ NRING(28),AMAT(30,4)                                  2500340
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ           2500350
      DIMENSIØN ST(72,31)                                                  2500360
      DATA A/-A   -/                                                       2500370
C                                                                          2500500
      GØTØ (771,772,773,774,775,776,7077),KGEØM                            2500510
C     GEØMETRY FØR ELIPSE(G3=ØFFSET DISTANCE )                             2500520
  771 A=G1                                                                 2500530
      BE=G2                                                                2500540
      BETA = BE                                                            2500550
      BESQ=BE**2                                                           2500560
      ASQ=A**2                                                             2500570
      SN = DSIN(PHI)                                                       2500580
      CS = DCØS(PHI)                                                       2500590
      SNSQ = SN**2                                                         2500600
      CSSQ = CS**2                                                         2500610
      R2 = A*DSQRT(1.0/(SNSQ+BESQ*CSSQ))                                   2500620
      R2SQ = R2**2                                                         2500630
      RØ=R2*SN                                                             2500640
      R1=R2*R2SQ*BESQ/ASQ                                                  2500650
      BESQ=BE**2                                                           2500660
      R1DØT=0.C                                                            2500670
      IF(KGEØM.EQ.1.AND.BETA.NE.1.C.AND.SN.NE.0.0)R1DØT=3.0*(R2*BETA/      2500680
     1A) **2*(CS/SNSQ)*(R1*SN-RØ)                                          2500690
      IF(SN.EQ. 0.0)GØ TØ 779                                              2500700
      R2 = R2-G3/SN                                                        2500710
      R2SQ = R2**2                                                         2500720
```

```
      RØ = RØ-G3
      GØ TØ 7775
  779 IF(G3 .EQ. 0.0)GØ TØ 7775
      R1DØT = 3.0*G3
      RØ = -G3
      GØ TØ 7775
C     GEØMETRY FØR ØGIVE
  772 R1=G1
      C=G2
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      IF (SN.EQ.0.0) GØTØ 777
      R2=R1-C/SN
      GØTØ 778
  777 R2 = 1.0
  778 RØ = R1*SN-C
      R1DØT=0.C
      GØTØ 7775
C     GEØMETRY FØR CØNE
  773 CS = CØS(G1)
      SN=SIN(G1)
      S=PHI
      S1=1.0/S
      R2=CS*SN*PHI
      RØ=PHI*CS
      R1DØT=0.C
      GØTØ 7775
C     GEØMETRY FØR CYLINDER
  774 RØ = G1
      R1DØT=0.0
      SN = 1.0
      CS = 1.0
      GØTØ 7775
C   MØDIFIED  ELLIPSE
  775 XNEXP = G1
      A    =G2
      XN1 = 1.C + XNEXP
      XN2 = 1.0/XN1
      XN3 = XN1 + 1.0
      XN4 = XN3 + 1.0
      XN5 = XN4/XN1
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      R2   = A*(2.0/(1.0+SN**XN1))**XN2
      R1   = (A/2.0)*(R2/A)**XN3
      RØ=R2*SN
      R1DØT = -XN3*A*(SN**XNEXP*CS/4.0)*(2.0/(1.0+SN**XN1))**XN5
      GØTØ 7775
C     GENERAL GEØMETRY
  776 SN = DSIN(PHI)
      CS = DCØS(PHI)
      TAN= SN/CS
      SEC= 1.0/CS
      IF (TIME.EQ.TIC) CALL GEØMET
      ARG = PHI
      DØ 204 J=1,100
      PHØ = PSI(J)
      IF (ANG.EQ.A) IF (ARG-PHØ) 221,223,204
      IF (PHØ-ARG) 221,223,204
  221 IF (J-1) 8502,8502,224
  204 CØNTINUE
```

```
      GØ TØ 8503                                                        2501340
  223 RØ = RAD(J)                                                       2501350
      R1 = CUR1(J)                                                      2501360
      R2 = CUR2(J)                                                      2501370
      R1DØT = DR1DP(J)                                                  2501380
      GØ TØ 7775                                                        2501390
 8502 NERRØR = 41                                                       2501400
      GØ TØ 8888                                                        2501410
 8503 NERRØR = 42                                                       2501420
 8888 NIX = 1                                                           2501430
      GØ TØ 8889                                                        2501440
  224 SUB1 = ARG-PSI(J-1)                                               2501450
      SUB2 = PSI(J)-PSI(J-1)                                            2501460
      RØ = RAD(J-1)+(RAD(J)-RAD(J-1))*SUB1/SUB2                         2501470
      R1 = CUR1(J-1)+(CUR1(J)-CUR1(J-1))*SUB1/SUB2                      2501480
      R2 = CUR2(J-1)+(CUR2(J)-CUR2(J-1))*SUB1/SUB2                      2501490
      R1DØT = DR1DP(J-1)+(DR1DP(J)-DR1DP(J-1))*SUB1/SUB2                2501500
      GØTØ 7775                                                         2501510
C     ISØTENSØID GEØMETRY                                               2501520
 7077 CØNTINUE                                                          2501530
      SN = DSIN(PHI)                                                    2501540
      CS = DCØS(PHI)                                                    2501550
      A  = G1                                                           2501560
      R2 = A/DSQRT(SN)                                                  2501570
      R1 = 0.5 * R2                                                     2501580
      RØ = R2 * SN                                                      2501590
      R1DØT = - ((A**2)*0.5)*(R1*CS)/RØ**2                              2501600
 7775 TAN=SN/CS                                                         2501610
      IF(TIME.EQ.TIC) RTICK=RØ                                          2501620
      IF (NCYC.GT.1) GØ TØ 491                                          2501630
      IF (TIME.NE.TIC) GØ TØ 491                                        2501640
      RADUS(ITIC) = RØ                                                  2501650
      AMAT(ITIC,1) = SAVY(7)                                            2501540
      AMAT(ITIC,2) = SAVY(8)                                            2501550
      IF (NSC.NE.1) GØ TØ 491                                           2501680
      SADUS(JTIC) = RØ                                                  2501690
      AMAT(JTIC,3) = SAVY(7)                                            2501580
      AMAT(JTIC,4) = SAVY(8)                                            2501590
  491 CØNTINUE                                                          2501720
      RØSQ = RØ**2                                                      2501730
      XNSQ=XN**2                                                        2501740
      CN=CS*SN                                                          2501750
      X1CS=1.0/CS                                                       2501760
      TN=SN/CS                                                          2501770
      X1RØ=1.0/RØ                                                       2501780
      X1RØSQ=1.0/RØ**2                                                  2501790
      X1CSRØ=1.0/(CS*RØ)                                                2501800
      CN1RØ=CN/RØ                                                       2501810
      SN1RØ=SN/RØ                                                       2501820
      CS1RØ=CS/RØ                                                       2501830
      SNSQ=SN**2                                                        2501840
      CSSQ=CS**2                                                        2501850
      IF(KGEØM.EQ.4.ØR.KGEØM.EQ.3) GØTØ 79                              2501860
      R1SQ = R1**2                                                      2501870
      R2SQ = R2**2                                                      2501880
      X1SN=1.0/SN                                                       2501890
      X1SNRØ=1.0/(SN*RØ)                                                2501900
      X1R1=1.0/R1                                                       2501910
      X1R2=1.0/R2                                                       2501920
      CS1R1=CS/R1                                                       2501930
      CS1R2=CS/R2                                                       2501940
```

```
      SN1R1=SN/R1
      XIR1SQ=1.0/R1**2
   79 XNTTH=0.0
      XNTPH=0.0
      XMTTH=0.0
      XMTPH = 0.
C
C     CØMPUTATIØN ØF K AND D FØR MATERIAL PRØPETY INPUT
C
      HØ = 0.0
      T = 0.0
      HI = 0.0
      RHØR = 0.0
      RHØS = 0.0
      RHØI = 0.0
      RHØC = 0.0
      CTH = 0.0
      CPH = 0.0
      YBARI = 0.0
      YBARC = 0.0
      YBARØ = 0.0
      AA = 0.0
      GØ TØ (711,600,711,32,33,34,35,36,37,28,29,30),ISTTAB
C     THICK
  600 GØ TØ (703,702,701,701),THICK
  701 HØ= ST(4,LL)
  702 T = ST(3,LL)
      RHØC = ST(NCØNT-1,LL)
  703 HI= ST(2,LL)
      RHØI = ST(NCØNT,LL)
      GØ TØ 40
C     ST11,ST12,ST13
   30 HØ= ST(14,LL)
   29 T = ST(13,LL)
      RHØC = ST(NCØNT-3,LL)
   28 HI= ST(12,LL)
      RHØI = ST(NCØNT-2,LL)
      RHØS = ST(NCØNT-1,LL)
      RHØR = ST(NCØNT,LL)
      GJPH= ST(2,LL)
      GJTH= ST(3,LL)
      APH = ST(4,LL)
      ATH = ST(5,LL)
      CPH = ST(6,LL)
      CTH = ST(7,LL)
      XIPH = ST(8,LL)
      XITH= ST(9,LL)
      SPH = ST(10,LL)
      STH = ST(11,LL)
      AA = RHØR*XITH+RHØS*XIPH
      GØ TØ 40
C     RWAF1,RWAF2,RWAF3
   34 HØ = ST(10,LL)
   33 T = ST(9,LL)
      RHØC = ST(NCØNT-2,LL)
   32 HI = ST(8,LL)
      RHØI = ST(NCØNT-1,LL)
      RHØS = ST(NCØNT,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH= ST(4,LL)
```

```
      SPH = ST(5,LL)
      BETTA=ST(6,LL)
      ZETTA = ST(7,LL)
      ATH = APH
      CTH = CPH
      XITH= XIPH
      STH = SPH
      RHØR = RHØS
      AA = RHØS*XITH
      GØ TØ 40
C     ISG1,ISG2,ISG3
   37 HØ = ST(9,LL)
   36 T = ST(8,LL)
      RHØC = ST(NCØNT-2,LL)
   35 HI = ST(7,LL)
      RHØI = ST(NCØNT-1,LL)
      RHØS = ST(NCØNT,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH = ST(4,LL)
      SPH = ST(5,LL)
      BETTA = ST(6,LL)
      ATH = APH
      CTH = CPH
      XITH = XIPH
      STH = SPH
      RHØR = RHØS
      AA = RHØS*XITH
      GØ TØ 40
C     ST10,RWAF
C     RANKIN=THSTND MEANS INTERPØLATE,CØMPUTE NTEMP,MTEMP
C     RANKIN=NØTHRM MEANS DØ NØT INTERPØLATE,DØ NØT CØMPUTE NTEMP,NTEMP
C     RANKIN=THCNST MEANS DØ NØT AVERAGE, BUT INTERPØLATE,CØMPUTE
C                                                    NTEMP, MTEMP
C     RANKIN=THINHØ MEANS INTERPØLATE,BUT DØ NØT CØMPUTE NTEMP,MTEMP
C
  711 CØNTINUE
      XK11=ST(2,LL)
      XK12=ST(3,LL)
      XK22 = ST(4,LL)
      XK33 = ST(5,LL)
      XD11 = ST(6,LL)
      XD12 = ST(7,LL)
      XD22 = ST(8,LL)
      XD33 = ST(9,LL)
      XC11 = ST(10,LL)
      XC22 = ST(11,LL)
      XC15 = ST(12,LL)
      XC16 = ST(13,LL)
      XMERD = ST(NCØNT-5,LL)
      XPRES = ST(NCØNT-4,LL)
      XMØNT = ST(NCØNT-3,LL)
      AZERØ = ST(NCØNT-2,LL)
      AØNE = ST(NCØNT-1,LL)
      ATWØ = ST(NCØNT,LL)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C
   40 CØNTINUE
      TEMP3= (1.0-XNUPT * XNUTP)
```

```
      PERM= TEMP3
      E1= (ETHET(1)+ EPHI(1))/2.
      E2= (ETHET(2)+ EPHI(2))/2.
      ES1= E1+E2
      GØ TØ (42,47,49,41),THICK
   41 GØ TØ (103,42,103,42,47,49,42,47,49,42,47,49),ISTTAB
C
C     SINGLE SHEET
C
   42 TEMP1= ETHET(1) * HI
      TEMP2= TEMP1 * HI**2
      XK11= TEMP1/TEMP3
      XD11= TEMP2/(12.0* TEMP3)
      TEMP1= EPHI(1)* HI
      TEMP2= TEMP1*HI**2
      XK22= TEMP1/TEMP3
      XD22=-TEMP2/(12.0* TEMP3)
      XK33= XGPT(1)* HI
      XD33= XK33*HI**2/12.0
      YBARI = C.0
      YBARC = 0.0
      YBARØ = 0.0
      ATHR = RHØI*HI**3/12.0
      GØ TØ 55
C
C     EQUAL SHEETS
C
   47 EPSUM= EPHI(1)+ EPHI(2)
      ETSUM= ETHET(1)+ ETHET(2)
      XK11= ETSUM * HI/PERM
      XK22= EPSUM * HI/PERM
      XK33= HI*(XGPT(1)+ XGPT(2))
      ZBRIN = (HI*(E1+3.0*E2)+2.0*E2*T)/(2.0*ES1)
      ZBRØUT = (HI*(E2+3.0*E1)+2.0*E1*T)/(2.0*ES1)
      ZBHIN= (ZBRIN-HI/2.0)**2
      ZBHØUT=(ZBRØUT-HI/2.0)**2
      XD33= (HI**3*(XGPT(1)+XGPT(2)))/12.0+ HI*(XGPT(1)* ZBHIN
     1     +  XGPT(2)* ZBHØUT)
      XD11=(XK11* HI**2)/12.+ HI*( ETHET(1) * ZBHIN + ETHET(2)*ZBHØUT)
     1/PERM
      XD22=(XK22* HI**2)/12.+ HI*( EPHI(1) * ZBHIN + EPHI(2)* ZBHØUT)
     1/PERM
      YBARI = ZBRIN-HI/2.C
      YBARC = ZBRIN-HI-T/2.0
      YBARØ = HI/2.0-ZBRØUT
      ATHR = (RHØC*T**3+RHØI*2.0*HI**3)/12.0+RHØI*HI*(ZBHIN+ZBHØUT)
      GØ TØ 55
C
C     UNEQUAL FACE SHEETS
C
   49 CØNTINUE
      ZBRIN =((E1*HI**2)+(E2*HØ**2) +(2.0*E2*HØ*HI) +(2.0*E2*HØ*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBRØUT=((E1*HI**2)+(E2*HØ**2) +(2.0*E1*HØ*HI) +(2.0*E1*HI*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBHIN =(ZBRIN-HI/2.0)**2
      ZBHØUT =(ZBRØUT-HØ/2.0)**2
      XK11= (ETHET(1)* HI + ETHET(2)* HØ)/PERM
      XK22= (EPHI(1) * HI + EPHI(2) * HØ)/PERM
      XK33= XGPT(1)*HI + XGPT(2) * HØ
      XD33 = (XGPT(1)*HI**3+XGPT(2)*HØ**3)/12.+HI*(XGPT(1)*ZBHIN)+
```

```
     1 XGPT(2)*ZBHØUT*HØ
      D11 =  (ETHET(1)*HI**3 + ETHET(2)*HØ**3)/12.
      XD11=(D11+ (HI*ETHET(1)*ZBHIN)    + (HØ*ETHET(2)*ZBHØUT))/PERM
      D22 =  (EPHI(1)* HI**3 + EPHI(2)*HØ**3)/12.
      XD22= ( D22 +(HI*EPHI(1)*ZBHIN) + (HØ*EPHI(2)* ZBHØUT)) /PERM
      YBARI = ZBRIN-HI/2.0
      YBARC = ZBRIN-HI-T/2.0
      YBARØ = HØ/2.0-ZBRØUT
      ATHR = (RHØC*T**3+RHØI*(HI**3+HØ**3))/12.0+RHØI*(HI*ZBHIN+
     1       HØ*ZBHØUT)
C
C     DETERMINE COMPLETE CONSTANTS DEPENDENT ØN REINFØRCEMENT CLUE
C
   55 CØNTINUE
      RØI = RØ-YBARI*SN
      RØU = RØ-YBARØ*SN
      RØC = RØ-YBARC*SN
      IF (THICK.EQ.2) HØ = HI
      IF (ISTTAB.EQ.5.ØR.ISTTAB.EQ.8.ØR.ISTTAB.EQ.11) HØ = HI
      D3 = RHØI*RØI*HI
      D4 = RHØC*RØC*T
      D5 = RHØI*RØU*HØ
      C3 = RHØI*HI
      C4 = RHØC*T
      C5 = RHØI*HØ
      DD = D3+D4+D5
      CC = C3+C4+C5
      XMERD = DD*ØMEGA*CS
      XPRES = -DD*ØMEGA*SN
      XMØNT = -(D3*YBARI+D4*YBARC+D5*YBARØ)*ØMEGA*CS
      AZERØ = CC
      AØNE = C3*YBARI+C4*YBARC+C5*YBARØ
      IF(ISTTAB .EQ.2)GØ TØ 103
      TBARR = ATH/STH
      TBARS = APH/SPH
      RØR = RØ-CTH*SN
      RØS = RØ-CPH*SN
      EASTH=ER*ATH/STH
      EASPH=ES*APH/SPH
      EISPH= ES* XIPH/SPH
      EISTH= ER* XITH/STH
      D1 = RHØR*RØR*TBARR
      D2 = RHØS*RØS*TBARS
      C1 = RHØR*TBARR
      C2 = RHØS*TBARS
      DD = D1+D2+D3+D4+D5
      CC = C1+C2+C3+C4+C5
      GØ TØ (58,60,100),KLUE2
C
C     ST CLUE (11,12,13)
C
   58 CØNTINUE
      XK12= XK11*XNUTP
      XK11= XK11+ EASTH
      XK22= XK22+ EASPH
      XC11= EASTH*CTH
      XC22= EASPH*CPH
      XD22= - XD22 - EISPH
      XD33= XD33 + GJPH/(4.0*SPH)+ GJTH/(4.0*STH)
      XD12= -XD11*XNUTP
      XD11= -XD11- EISTH
```

```
      XK21 = XK12
      XD21 = XD12
      XMERD = DD*ØMEGA*CS
      XPRES = -DD*ØMEGA*SN
      XMØNT = -(D1*CTH+D2*CPH+D3*YBARI+D4*YBARC+D5*YBARØ)*ØMEGA*CS
      AZERØ = CC
      AØNE = C1*CTH+C2*CPH+C3*YBARI+C4*YBARC+C5*YBARØ
      GØ TØ 103
C     RWA CLUE (1,2,3)
C
   60 CØNTINUE
      SINB =SIN(BETTA)
      CØSB =CØS(BETTA)
      SN2TØ4 = 2*(SINB**4.)
      D= STH*(CØSB+SINB)
      ED = ER*ATH/D
      SINB2= SINB**2.
      HL = 2.0*(ABS(ZETTA)-ABS(CTH))
      I2=(ATH**3.)/(3* HL**2)
   95 XC22 = 2.0*CTH*CØSB**3*ED
      XC15 = 2.0*CTH*CØSB*SINB2*ED
      XC16 = XC15
      GRI=  ER* I2/(2.0*(1.0 + XNUTP)*D)
      XC11 = CTH*SN2TØ4/CØSB*ED
      EDI = ER*XITH/D
      SN4TØ2 = 4.*SINB2
      XD22 = -XD22-2.0*CØSB**3*EDI-SN4TØ2*CØSB*GRI
      TB= 2.0* BETTA
      XD33 = XD33+((4.0*CØS(TB)*
     1*2*GRI)/ CØSB) + (2.0*CØSB*SINB2*EDI)
      XD12 = -XD11*XNUTP-(2.0*CØSB
     1*SINB2*EDI)-(SN4TØ2*CØSB*GRI )
      XK12= XK11*XNUTP + (2.0*CØSB*SINB2*ED)
      XK22=XK22+(2*CØSB**3*ED)
      XK33=XK33+(2*CØSB*SINB2*ED)
      XK11=XK11+(SN2TØ4*ED/CØSB)
      XD11 = -XD11-SN2TØ4*EDI/CØSB-(
     1 SN4TØ2*CØSB*GRI)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 108
C
C     ISG CLUE (1,2,3)
C
  100 CØNTINUE
      SNB =SIN(BETTA)
      CSB =CØS(BETTA)
      TBETTA= 2.0*BETTA
      CS2B= CØS(TBETTA)
      ØNEC2B=(1.0+ CS2B)/2.
      SCB2  =(SNB-CS2B*SNB + 2.)/(2.0*CSB)
      SN2B  =SIN(TBETTA) /2.
      XK12=XK11*XNUTP + (EASTH*SNB*ØNEC2B/CSB)
      XK11=XK11+ EASTH*SCB2
      XK22=XK22+ EASTH*(CSB/SNB*ØNEC2B)
      XK33=XK33+ EASTH* SN2B
      XC11=      (EASTH*CTH* SCB2 )
      XC15=EASTH*CTH*( SNB* ØNEC2B/CSB )
      XC16=EASTH*CTH*SN2B
      XC22= EASTH*CTH* (CSB/SNB * ØNEC2B)
      XD12=-XD11*XNUTP- EISTH*(SNB*ØNEC2B/CSB)
```

```
      XD11=-XD11- EISTH*SCB2
      XD22 = -XD22-EISTH*(CSB/SNB*ØNEC2B)
      XD33= XD33+ EISTH*SN2B
      XK21 = XK12
      XD21 = XD12
C
C
  108 XMERD = (DD-D2)*ØMEGA*CS
      XPRES = -(DD-D2)*ØMEGA*SN
      XMØNT = -(D1*CTH+D3*YBARI+D4*YBARC+D5*YBARØ)*ØMEGA*CS
      AZERØ = CC-C2
      AØNE = C1*CTH+C3*YBARI+C4*YBARC+C5*YBARØ
C
  103 CØNTINUE
      IF (KGEØM.NE.4) GØ TØ 105
      XMERD = C.0
      XMØNT = 0.0
  105 CØNTINUE
      IF(ISTAB.NE.1.AND.ISTAB.NE.3) ATWØ=AA+ATHR
C
      GØ TØ (716,714,715,714),KELVIN
  716 TII = ST(NRØW+1,LL)
      TIK = ST(NRØW+2,LL)
      TØK = ST(NRØW+3,LL)
      TØØ = ST(NRØW+4,LL)
      GØTØ 717
  715 TII = ST(NRØW+1,LL)
      TIK = TII
      TØK = TII
      TØØ = TII
C
  717 TEMP11= ALPHTH(1)+ XNUTP * ALPHPH(1)
      TEMP12= ALPHTH(2)+ XNUTP * ALPHPH(2)
      TEMP21= ALPHPH(1)+ XNUPT * ALPHTH(1)
      TEMP22= ALPHPH(2)+ XNUPT * ALPHTH(2)
      TEMP3 = 1-XNUPT*XNUTP
      TEMP4 = HI/4.0
      ETHK1=  ETHET(1)*TEMP11/TEMP3
      TEMP5 = HI**2/24.0
      ETHK2 = ETHET(2)*TEMP12/TEMP3
      TEMP61= TII+ TIK-2* TEFREE
      TEMP62= TØØ+ TØK-2* TEFREE
      TEMP71= 2.0* TII +TIK-3*TEFREE
      TEMP72= 2.0* TØØ +TØK-3*TEFREE
      EPHK1 = EPHI(1)*TEMP21/TEMP3
      EPHK2 = EPHI(2)*TEMP22/TEMP3
      GØ TØ (811,812,813,814),THICK
C
C
  811 XNTTH= ETHK1   *          TEMP4 * (TEMP61+ TEMP62)
      XNTPH= EPHK1   *          TEMP4 * (TEMP61 + TEMP62)
      XMTTH= ETHK1   *          TEMP5 * (TEMP71- TEMP72)
      XMTPH= EPHK1   *          TEMP5 * (TEMP71 - TEMP72)
      GØ TØ 714
  812 TI = (HI*(E2-E1)+2.0*E2*T)/(2.0*(E1+E2))
      TØ = (HI*(E1-E2)+2.0*E1*T)/(2.0*(E1+E2))
      TEMP8= HI/2.0
      XNTTH = ETHK1   *       TEMP8*TEMP61 + ETHK2   *       TEMP8*
     1TEMP62
      XNTPH = EPHK1   *       TEMP8*TEMP61 + EPHK2   *       TEMP8*
     1TEMP62
```

```
      XMTTH =(ETHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (ETHK2 *
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))
      XMTPH =(EPHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (EPHK2 *
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))
      GØ TØ 714
  813 TI = (E2*HØ**2-E1*HI**2+2.0*E2*HØ*T)/(2.0*(E1*HI+E2*HØ))
      TØ = (E1*HI**2-E2*HØ**2+2.0*E1*HI*T)/(2.0*(E1*HI+E2*HØ))
      XNTTH = ETHK1*0.5*(HI*TEMP61)+ETHK2*0.5*(HØ*TEMP62)
      XNTPH= EPHK1*0.5*(HI*TEMP61)+ EPHK2*0.5*(HØ*TEMP62)
      XMTTH = ETHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-ETHK2*0.5*(HØ
     1**2*TEMP72/3.+TØ*HØ*TEMP62)
      XMTPH = EPHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-EPHK2*0.5*(HØ
     1**2*TEMP72/3.+ TØ*HØ*TEMP62)
      GØ TØ 714
  814 TEMP10=((-XK11*XD11)**.5)/(48.0**.5)
      TEM11 =((-XK22*XD22)**.5)/(48.0**.5)
      XNTTH =(XK11/4.0 *TEMP11)* TEMP61 + (XK11/4.0*TEMP12) * TEMP62
      XNTPH =(XK22/4.0 *TEMP21)* TEMP61 + (XK22/4.0*TEMP22) * TEMP62
      XMTTH =  TEMP10*(TEMP11*TEMP71 - TEMP12* TEMP72)
      XMTPH =  TEM11 *(TEMP21*TEMP71 - TEMP22* TEMP72)
  714 CØNTINUE
 8889 RETURN
      END
```

```
 FØR,IS GEØMET,GEØMET
      SUBRØUTINE GEØMET
C     THIS SUBRØUTINE CALCULATES THE GEØMETRY FØR A SHELL SEGMENT.
C     THE INPUT VARIABLES ARE . . .
C              RI(I) - - DISTANCE FRØM AXIS ØF REV. TØ PØINTS
C                        ØN SHELL MERIDIAN.
C              ZI(I) - - DISTANCE ALØNG AXIS ØF REV. TØ THE
C                        INTERSECTIØN ØF THE CØRRESPØNDING RI(I) AND
C                        THE AXIS ØF REV.
C              NRZIN - - NUMBER ØF (RI,ZI) PAIRS READ AS INPUT.
C
      CØMMØN /SPLINS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1       DR1DP(100),ZI(14),RI(14),NRZIN
      DIMENSIØN CI(4,13),DRDZ(14),SØUT(14),S(101),RADD(100)
C
      FUN(ARG) = SQRT(1.0 + ARG**2)
C
      RADS = 3.1415926/180.0
      DATA B/-B   -/
      AMULT = 1.0
      IF (ANG.EQ.B) AMULT = -1.0
C
C     PASS SPLINE CURVE THRØUGH INPUT PØINTS ØN SHELL MERIDIAN, AND
C     CØMPUTE CR/DZ AT THESE PØINTS.
C
      CALL PLICØ (ZI,RI,NRZIN,CI)
      NDELZ = NRZIN - 1
      DØ 60 I=1,NRZIN
      CALL PLINE (ZI,RI,NRZIN,CI,ZI(I),FAKE1,DRDZ(I),FAKE2)
   60 CØNTINUE
C
C     CØMPUTE MERIDIØNAL ARC LENGTH TØ INTERPØLATED PØINTS BY
C     NUMERICAL INTEGRATIØN (SIMPSØNS RULE).  SINCE SIMPSØNS RULE
C     REQUIRES AN EVEN NUMBER ØF PARTITIØNS, INTERPØLATE A PØINT
C     MIDWAY BETWEEN EACH PAIR ØF PØINTS USING SUBRØUTINE SPLINE.
C
      SØUT(1) = 0.
      DØ 70 I=1,NDELZ
      DZ2=(ZI(I+1)-ZI(I))/2.0
      DZ6=DZ2/3.0
      CALL PLINE (ZI,RI,NRZIN,CI,ZI(I)+DZ2,FAKE1,DRDZM,FAKE2)
      SØUT(I+1) = SØUT(I) + DZ6*(FUN(DRDZ(I)) + 4.0*FUN(DRDZM) +
     1            FUN(DRDZ(I+1)))
   70 CØNTINUE
C
C     USE SPLICØ TØ REPRESENT RI(I) AS A FUNCTIØN ØF SØUT(I).  THEN USE
C     SPLINE TØ INTERPØLATE RADD AND CØRRESPØNDING DERIVATIVES.  FRØM
C     THESE, CØMPUTE THE TWØ PRINCIPAL RADII ØF CURVATURE,
C       CUR1 = 1/R1
C       CUR2 = 1/R2
C
      ØLDH1 = SØUT(NRZIN)/99.0
      CALL PLICØ (SØUT,RI,NRZIN,CI)
      DØ 110 I=1,100
      S(I) = FLØAT(I-1)*ØLDH1
      CALL PLINE (SØUT,RI,NRZIN,CI,S(I),RAD(I),RADD(I),RADD2)
      IF (ABS(RADD(I)).GT.1.0) RADD(I)=1.0
      FACTØR = SQRT(1.0-RADD(I)**2)
      CUR1(I) = -RADD2/FACTØR
      CUR2(I) = FACTØR/RAD(I)
  110 CØNTINUE
```

```
      DØ 180 J=1,100
      CØSPSI = AMULT*RADD(J)
      PSI(J) = ARCØS(CØSPSI)
      SINPSI = -AMULT*RAD(J)*CUR2(J)
      IF (ANG.EQ.B) GØ TØ 179
      PSI(J) = 2.0*3.1415926-PSI(J)
  179 CØNTINUE
      CUR1(J) = -AMULT/CUR1(J)
      CUR2(J) = -AMULT/CUR2(J)
      IF (J.EQ.1) GØ TØ 180
      I = 1
      IF (J.EQ.2) GØ TØ 181
      I = 2
  181 IF (ANG.EQ.B) GØ TØ 190
      DR1DP(J-1) = (CUR1(J)-CUR1(J-I))/(PSI(J)-PSI(J-I))
      GØ TØ 180
  190 DR1DP(J-1) = (CUR1(J-I)-CUR1(J))/(PSI(J-I)-PSI(J))
  180 CØNTINUE
      DR1DP(100) = DR1DP(99)
      DØ 42 J=1,100
      DR1DP(J) = DR1DP(J)*0.1
   42 CØNTINUE
      RETURN
      END
```

```
FØR,IS PLINE,PLINE
      SUBRØUTINE PLINE (X,Y,M,C,XINT,YINT,DYDX,D2YDX2)
C     SUBRØUTINE FØR SPLINE FIT INTERPØLATIØN IN THE TABLE ØF VALUES
C     (X1,Y1) TØ (XM,YM), WHERE M MAY BE AS LARGE AS 100, WHERE THE '
C     CØNSTANTS C(1,K),C(2,K),C(3,K) AND C(4,K) ARE ALREADY CØMPUTED
C     AND STØRED.
C     SUBRØUTINE ALSØ CØMPUTES DY/DX AND D2Y/DX2 AT XINT.
      DIMENSIØN X(14),Y(14),C(4,13)
      IF (XINT-X(1)) 80,10,20
   10 YINT = Y(1)
      K=1
      GØ TØ 70
   20 K = 1
   30 IF (XINT-X(K+1)) 60,40,50
   40 YINT = Y(K+1)
      GØ TØ 70
   50 K = K + 1
      IF (M-K) 80,80,30
   60 YINT = (X(K+1) - XINT)*(C(1,K)*(X(K+1)-XINT)**2+C(3,K))
      YINT = YINT + (XINT-X(K))*(C(2,K)*(XINT-X(K))**2+C(4,K))
   70 DYDX=-3.0*(C(1,K)*(X(K+1)-XINT)**2-C(2,K)*(XINT-X(K))**2)
     1      -C(3,K)+C(4,K)
      D2YDX2=6.0*(C(1,K)*(X(K+1)-XINT)+C(2,K)*(XINT-X(K)))
      RETURN
   80 WRITE (6,90)
   90 FØRMAT (31H ØUT ØF RANGE FØR INTERPØLATIØN)
      RETURN
      END
```

```
FØR,IS PLICØ,PLICØ
      SUBRØUTINE PLICØ (X,Y,M,C)
C     SUBRØUTINE TØ DETERMINE C(1,K),C(2,K),C(3,K) AND C(4,K).
      DIMENSIØN X(14),Y(14),A(14,3),B(14),Z(14)
      DIMENSIØN D(13),P(13),E(13),C(4,13)
      MM = M-1
      DØ 10 K=1,MM
      D(K) = X(K+1) - X(K)
      P(K) = D(K)/6.0
   10 E(K) = (Y(K+1)-Y(K))/D(K)
      DØ 20 K=2,MM
   20 B(K) = E(K) - E(K-1)
      A(1,2) = -1.0-D(1)/D(2)
      A(1,3) = D(1)/D(2)
      A(2,3) = P(2)-P(1)*A(1,3)
      A(2,2) = 2.0*(P(1)+P(2)) - P(1)*A(1,2)
      A(2,3) = A(2,3)/A(2,2)
      B(2) = B(2)/A(2,2)
      DØ 30 K=3,MM
      A(K,2) = 2.0*(P(K-1)+P(K))-P(K-1)*A(K-1,3)
      B(K) = B(K)-P(K-1)*B(K-1)
      A(K,3) = P(K)/A(K,2)
   30 B(K) = B(K)/A(K,2)
      Q = D(M-2)/D(M-1)
      A(M,1) = 1.0+Q+A(M-2,3)
      A(M,2) = -Q-A(M,1)*A(M-1,3)
      B(M) = B(M-2)-A(M,1)*B(M-1)
      Z(M) = B(M)/A(M,2)
      MN = M-2
      DØ 40 I=1,MN
      K = M-I
   40 Z(K) = B(K)-A(K,3)*Z(K+1)
      Z(1) = -A(1,2)*Z(2)-A(1,3)*Z(3)
      DØ 50 K=1,MM
      Q = 1.0/(6.0*D(K))
      C(1,K) = Z(K)*Q
      C(2,K) = Z(K+1)*Q
      C(3,K) = Y(K)/D(K)-Z(K)*P(K)
   50 C(4,K) = Y(K+1)/D(K)-Z(K+1)*P(K)
      RETURN
      END
```

SUBROUTINES DIF1 AND DIFF2

These subroutines are called in RIEMAN as necessary. DIF1 contains the differential equations for the THIC and ST clues, while DIFF2 contains the differential equations for the RWA and ISG clues. Geometry clues, trigonometric values and predicted values of the differential equation variables are passed via label common area, EQUAZN, to subroutines DIF1 or DIFF2. The coefficients for the mass and load terms, X1, X2, X3, and K are identified depending upon the pass number and convergence criterion.

The specific derivative equations and auxiliary equations are contained in these subroutines. The values of each derivative equation, YDOT, and each auxiliary equation, YA ---, are returned to RIEMAN via label common EQUAZN.

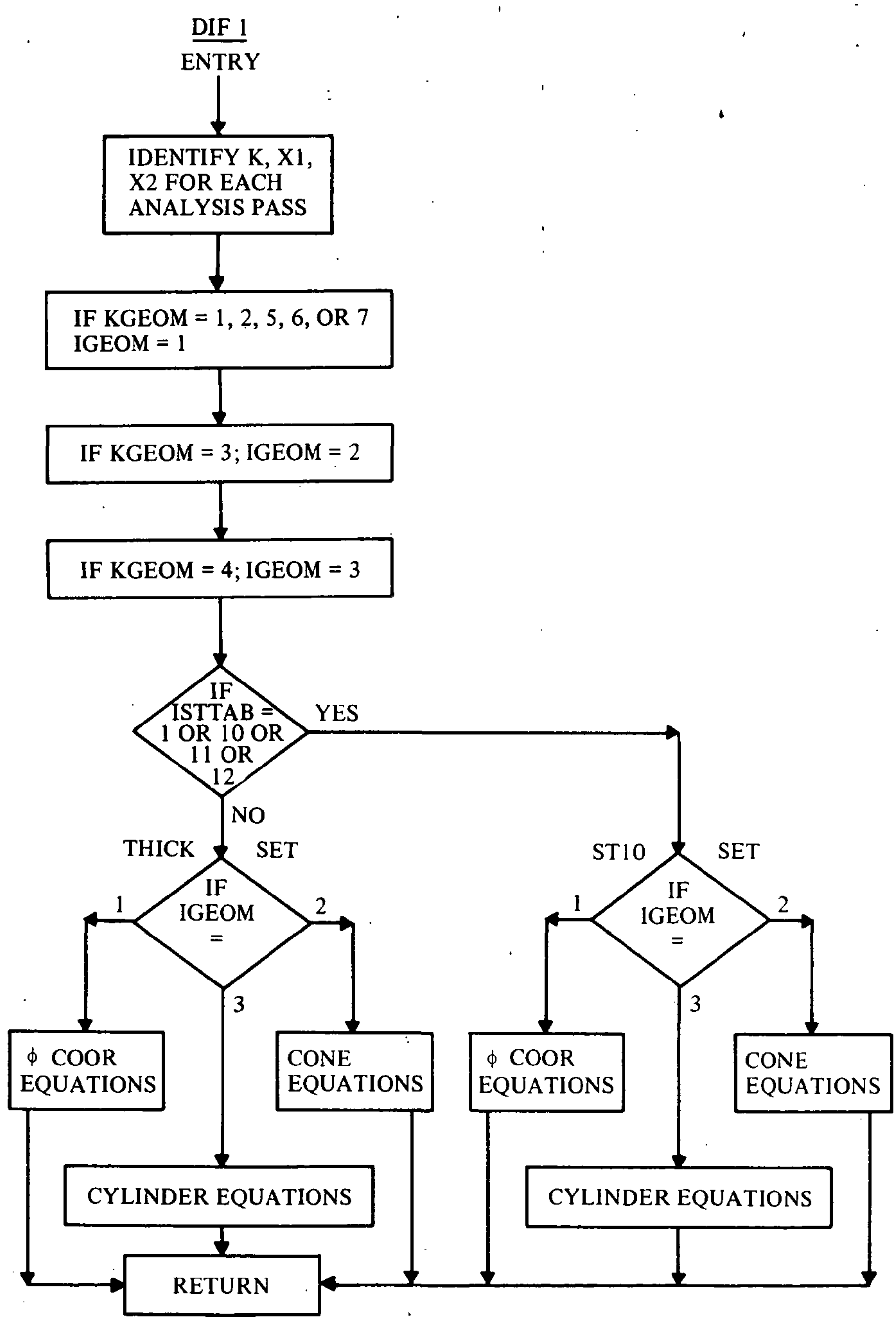
A special equation counter, I, is used in these subroutines, which counts in increments of eight. The first eight values of I, 1 through 57 (in increments of eight), correspond to the eight sets of initial conditions required to compute the segment stiffness matrices in subroutine SEGMAT. The subsequent values of I, 65 and 73 maximum (again in increments of eight) correspond to the computation of each set of eight equations for each loading condition (two conditions corresponding to rotation and static prestress respectively).

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)	
XN	n	
YDOT (I)	$T_{\phi\theta,\phi}$	$\frac{dT_{\phi\theta}}{ds}$
YDOT (I + 1)	$N_{\phi,\phi}$	$\frac{dN_{\phi}}{ds}$
YDOT (I + 2)	$J_{\phi,\phi}$	$\frac{dJ_{\phi}}{ds}$
YDOT (I + 3)	$M_{\phi,\phi}$	$\frac{dM_{\phi}}{ds}$
YDOT (I + 4)	$U,_{\phi}$	$\frac{dU}{ds}$
YDOT (I + 5)	$V,_{\phi}$	$\frac{dV}{ds}$
YDOT (I + 6)	$W,_{\phi}$	$\frac{dW}{ds}$
YDOT (I + 7)	$\Omega_{\theta,\phi}$	$\frac{d\Omega_{\theta}}{ds}$
YPRED (I)	$T_{\phi\theta}$	
YPRED (I + 1)	N_{ϕ}	
YPRED (I + 2)	J_{ϕ}	
YPRED (I + 3)	M_{ϕ}	
YPRED (I + 4)	U	
YPRED (I + 5)	V	
YPRED (I + 6)	W	
YPRED (I + 7)	Ω_{θ}	
YAMPT	$M_{\phi\theta}$	
YANTH	N_{θ}	
YAMTH	M_{θ}	

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
R2SQ	r_2^2
ROSQ	r_0^2
X1RO	$1/r_0$
S	s
XK12	K_{12}
XK21	K_{21}
XD12	D_{12}
XD21	D_{21}
XC11	C_{11}
XC22	C_{22}
XNSQ	n^2

Non-Linear Redefinitions (Ref. 1)

YDOT (I+2)	$^*J_{\phi,\phi}$	$\dfrac{d^*J_\phi}{ds}$
YPRED (I+2)	$^*J_\phi$	
YAJPH	J_ϕ	
XNL	a	
XNPHI	$\overline{N}_\phi$	


DIF 1
ENTRY
IDENTIFY K, X1, X2 FOR EACH ANALYSIS PASS
IF KGEOM = 1, 2, 5, 6, OR 7 IGEOM = 1
IF KGEOM = 3; IGEOM = 2
IF KGEOM = 4; IGEOM = 3
IF ISTTAB = 1 OR 10 OR 11 OR 12
YES
NO
THICK
SET
ST10
SET
IF IGEOM =
1
2
3
ϕ COOR EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
RETURN

```
FØR,IS DIF1,DIF1
      SUBRØUTINE DIF1 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YPRED
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ,
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,
     3                 SN1R1,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,
     5                 XD33,XD22,XD21,XD12,XK11,XK12,XK21,XK22,XK33,
     6                 XD11,XNPHI,BETA,XC16
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NIRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),
     1                YANTH,YAMTH,YAMPT,YAJPH,
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3                X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),DUM,
     8                XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9                XK11,XK12,XK21,XK22,XK33,XD11,
     A                XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2),(XNL(3),X3)
C     IF (NH.NE.0) WRITE(6,1333) PHI,SAVY
 1333 FØRMAT(1X,1P1E16.7,5X,1P6E16.7)
      IGEØM = 0
      IF (KGEØM.EQ.1.ØR.KGEØM.EQ.2.ØR.KGEØM.EQ.5.ØR.KGEØM.EQ.6) IGEØM =1
      IF (KGEØM.EQ.3) IGEØM=2
      IF(KGEØM.EQ.4) IGEØM=3
      IF ( KGEØM.EQ.7 ) IGEØM = 1
      K = 0
      IF (NH.EQ.0) K = 1
      IF(ISTTAB.EQ.1)  GØ TØ 7786
      IF(ISTTAB.GE.10)GØ TØ 7786
C     THE FØLLØWING EQUATIØNS ARE THE -THICK- SET
      GØ TØ (151,152,153),IGEØM
C   EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )
  151 YANTH      = XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(XN*YPRED(I+4)+
     1             YPRED(I+5)*CS-YPRED(I+6)*SN)*X1RØ+K*(XNUPT*XNTPH-
     2             XNTTH)
      YAMTH      = XNUPT*YPRED(I+3)-(XD11-XNUPT**2*XD22)*X1RØ*(X1RØ*(XN*
     1             YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)+K*
     2             (XNUPT*XMTPH-XMTTH)
      YAØPH      = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT      = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*
     1             YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*
     2             (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/
     3             XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*SN1RØ
```

```
      YDØT(I+4) = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+
     1            YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
     1            X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
     2            SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
     3            (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4            X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
     5            -R1*X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+SN/RØ*
     6            (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = R1*(YPRED(I+6)*X1R1+(1.0/(XK22-XNUTP**2*XK11))*
     1            (YPRED(I+1)-XNUTP*YANTH+K*(XNTPH-XNUTP*XNTTH)))
     2            -R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1            X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1            YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2            -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3            (X1*XFZEL1+X2*XFZEL2))
     4            -R1*X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1            +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2            (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3            XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4            -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5            (X1*SAVY(1)+X2*SAVY(4)))
     6            -R1*X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)-
     7            ATWØ*YAØPH))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1            YAJPH+K*XMTHLD)
     2            +R1*X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*
     1            YAMTH-K*(XMTPH-XNUTP*XMTTH))
      GØTØ 9005
C     EQUATIØNS FØR CØNE
  152 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1CS/S)*(XN*YPRED(I+4
     1            )+YPRED(I+5)*CS-YPRED(I+6)*SN)+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(1.0/S)*X1CS*(XD11-XNUPT**2*XD22)*((1.0/S)*
     1      X1CS*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)-
     2            K*(XMTTH-XNUPT*XMTPH)
      YAØPH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1     YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
     2            (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
     1            +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1            +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2            (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3            TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4            +X2*SAVY(6)))
     5            -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+TN/S*
     6            (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1            K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2            SAVY(6))
      EPSITH    = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
```

```
     1            YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1            (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2            XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
     3            -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1            -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2            -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3            (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4            X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     5            -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/(S*CS)*(AØNE*YPRED(I+4)
     6            -ATWØ*YAØPH))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1            *K
     2            +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH-
     1            K*(XMTPH-XNUTP*XMTTH))
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
  153 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1RØ*(XN*YPRED(I+4)-
     1            YPRED(I+6)))+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(X1RØ*(XD11-XNUPT**2*XD22))*(X1RØ*(XN*YPRED
     1            (I+4)-XNSQ*YPRED(I+6)))+K*(XNUPT*XMTPH-XMTTH)
      YAØPH     = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
     1            YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
     2            SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
     1            +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1            -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2            X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3            (X1*SAVY(3)+X2*SAVY(6)))
     4            -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+1.0/RØ*
     5            (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1            K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2            SAVY(6))
      EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1            EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2            X2*XFZEL2)
     3            -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1            XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2            YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3            (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     4            -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)
     5            -ATWØ*YAØPH))
      YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
     1            +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = (1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH+
     1            K*(XNUTP*XMTTH-XMTPH))
      GØ TØ 9005
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 7786 GØ TØ (4771,4772,4773),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -ST10- SET
C   EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )
 4771 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1            (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*XK11-
     1            XK12*XK21*X1RØ*(1.0/
     2       (XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+
     3      6)*SN)-(XC11+XK12*XC22*XD21/XD22*(1.0/(XK22+XC22**2/XD22)))*
     4       (X1RØ**2*(XN*YPRED(I+4)*SN-XN**2*YPRED(I+6))+YPRED(I+7)*CS*
     5       X1RØ)
      YAMTH     = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1            -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1            K*XMTPH)+(XC11*
     2        X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED(
     3        I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*XD21/(
     4        XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED
     5        (I+6))+YPRED(I+7)*CS*X1RØ)
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT     = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*
     1            YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*
     2            (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/
     3            XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*SN1RØ
      YDØT(I+4) = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+
     1            YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
     1            X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
     2            SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
     3            (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4            X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
     5            -R1*X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+SN/RØ*
     6            (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = R1*(YPRED(I+6)*X1R1-YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
     1            +(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+(XC22/
     1            XD22)*(YPRED(I+3)+K*XMTPH)-XK21*X1RØ*(XN*
     2           YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22
     3           )*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)
     4           *CS*X1RØ)))
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1            X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1            YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2            -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3            (X1*XFZEL1+X2*XFZEL2))
     4            -R1*X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1            +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2            (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3            XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4            -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5            (X1*SAVY(1)+X2*SAVY(4)))
     6            -R1*X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)-
     7            ATWØ*YAØPH))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1            YAJPH+K*XMTHLD)
     2            +R1*X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*((-XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-
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     1           (XK21/
     1          RØ)*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN))
     2          +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
     3          XD21/(XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     4          *YPRED(I+6))+YPRED(I+7)*CS*X1RØ))
      GØ TØ 9005
C     EQUATIØNS FØR CØNE
 4772 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1           (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(1.0/(CS*S))
     1           *(XK11-XK12*XK21*(
     2       1.0/(XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3       YPRED(I+6)*SN)-(XC11+(XK12*XD21*XC22/XD22)*(1.0/(XK22+XC22*
     4       *2/XD22)))*((1.0/(S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED
     5       (I+6))+YPRED(I+7)/S)
      YAMTH     = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1           -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1           K*XMTPH)+(XC11/
     2        (S*CS)+XD12*XK21/(S*CS))*(XC22/(XC22**2+XK22*XD22))*(XN*
     3        YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*
     4        XD21/(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*
     5        SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S)
      YAØPH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1     YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
     2           (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1           -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
     1           +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1           +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2           (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3           TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4           +X2*SAVY(6)))
     5           -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+TN/S*
     6           (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
     1           /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
     1           +K*XMTPH)-(XK21/(S*CS))*(XN*YPRED(I+4)+YPRED(
     2          I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22)*((1.0/(S**2*CS**
     3          2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S))
      EPSITH    = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1           YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1           (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2           XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
     3           -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1           -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2           -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3           (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4           X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     5           -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/(S*CS)*(AØNE*YPRED(I+4)
     6           -ATWØ*YAØPH))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1           *K
     2           +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
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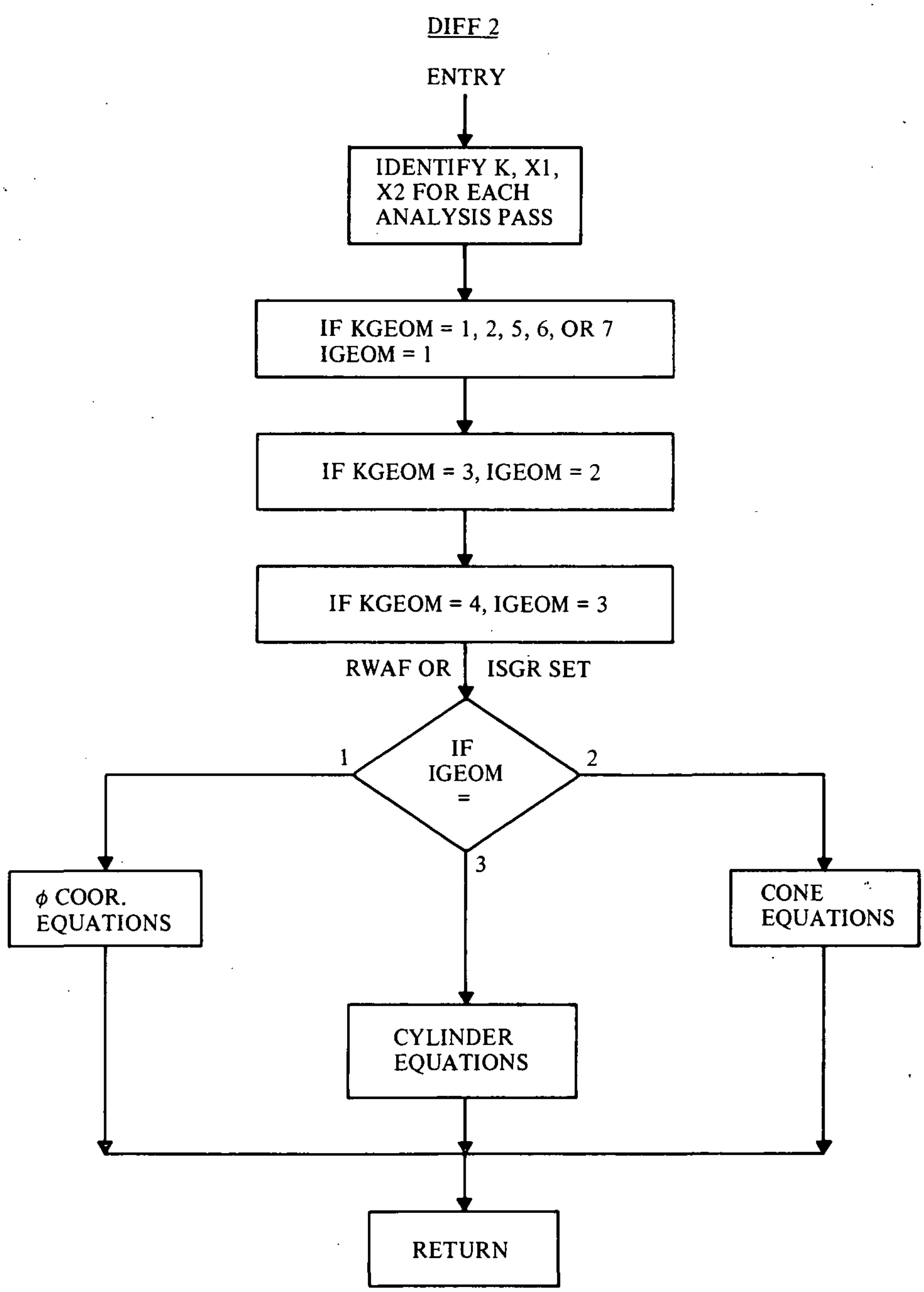
     1          (XN*
     1         YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)/(S*CS))
     2         +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
     1         XD21
     3         /(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*SN
     4         -XN**2*YPRED(I+6))+YPRED(I+7)/S)
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
 4773 YANTH      = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1          (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*(XK11-
     1           XK12*XK21*(1.0/(
     2       XK22+XC22**2/XD22))))*(XN*YPRED(I+4)-YPRED(I+6))-(XC11+(
     3       XK12*XC22*XD21/XD22)*(1.0/(XK22+XC22**2/XD22)))*(X1RØ**2*(
     4       XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
      YAMTH      = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1           -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
     1           K*XMTPH)+(XC11*
     2        X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED
     3        (I+4)-YPRED(I+6))+(XD11-XD12*XK22*XD21/(XC22**2+XK22*XD22)
     4        )*(X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
      YAØPH      = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
     1           YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
     2           SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1           -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
     1           +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)    = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1           -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2           X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3           (X1*SAVY(3)+X2*SAVY(6)))
     4           -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+1.0/RØ*
     5           (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5)  = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
     1           /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
     1           +K*XMTPH)-(XK21*X1RØ)*(XN*YPRED(I+4)-YPRED
     2      (I+6))-(XC22*XD21/XD22)*(X1RØSQ*(XN*(YPRED(I+4)-XN*YPRE
     3           D(I+6)))))
      EPSITH     = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)  = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1           EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2           X2*XFZEL2)
     3           -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2)  = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1           XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2           YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3           (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     4           -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)
     5           -ATWØ*YAØPH))
      YDØT(I+3)  = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
     1           +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)  = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
     1           X1RØ*(
     1         XN*YPRED(I+4)-YPRED(I+6)))+(XK22/(XC22**2+XK22*XD22))*(
     2           YPRED(I+3)+K*XMTPH)-(XK22*XD21/(XC22**2+XK22*XD22))*(
     3         X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
 9005 CØNTINUE
```


DIFF 2
ENTRY
IDENTIFY K, X1, X2 FOR EACH ANALYSIS PASS
IF KGEOM = 1, 2, 5, 6, OR 7 IGEOM = 1
IF KGEOM = 3, IGEOM = 2
IF KGEOM = 4, IGEOM = 3
RWAF OR ISGR SET
IF IGEOM =
1
2
3
ϕ COOR. EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
RETURN

```
FØR,IS DIFF2,DIFF2
      SUBRØUTINE DIFF2 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YPRED
      DØUBLE PRECISIØN YDØT,YASAVE,YANTH,YAMTH,YAMPT,YAJPH,S,SN,CS,SNSQ,
     1                 CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,X1RØ,X1RØSQ,X1SNRØ,
     2                 X1CSRØ,CN1RØ,SN1RØ,CS1RØ,X1R1,X1R2,CS1R1,CS1R2,
     3                 SN1R2,X1R1SQ,R2SQ,RØ,BESQ,RØSQ,XNSQ,R1,R2,S1,
     4                 R1DØT,XNTTH,XNTPH,XMTTH,XMTPH,XC11,XC22,XC15,
     5                 XD33,XD22,XC21,XD12,XK11,XK12,XK21,XK22,XK33,
     6                 XD11,XNPHI,BETA,XC16
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /EQUAZN/ YPRED(80),YDØT(80),YASAVE(80),
     1                 YANTH,YAMTH,YAMPT,YAJPH,
     2                 S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3                 X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4                 X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5    RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,
     6                 XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),DUM,
     8                 XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9                 XK11,XK12,XK21,XK22,XK33,XD11,
     A                 XNPHI,M,I,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2),(XNL(3),X3)
      IGEØM = C
      IF (KGEØM.EQ.1.ØR.KGEØM.EQ.2.ØR.KGEØM.EQ.5.ØR.KGEØM.EQ.6) IGEØM =1
      IF (KGEØM.EQ.3) IGEØM=2
      IF(KGEØM.EQ.4) IGEØM=3
      IF ( KGEØM.EQ.7 ) IGEØM = 1
      K = 0
      IF (NH.EQ.0) K = 1
 7447 GØ TØ (7341,7342,7343),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -RWAF- SET
C     EQUATIØNS FØR SHELLS ØF REVØLUTIØN ( PHI CØØRDINATE )
 7341 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3 YPRED(I+6)*SN)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     5 *YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22*XC22)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+
     3 X1RØ*YPRED(I+7)*CS)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-
     3 XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT = (1.0/(XC16*SN*X1RØ-XK33-SN*X1RØ*(XD33*SN/(      RØ)-XC16)))
     1        *((XK33*XD33-XC16**2)*X1RØ*(-2.0*XN*YPRED(I+7)+YPRED(I+4)*
```

```
     2         (CS*X1R1-CN1RØ)+XN*YPRED(I+5)*(X1R1+SN1RØ)+2.0*XN*YPRED
     3         (I+6)*CS*X1RØ)+YAØPH*SN*(X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*
     4         (XD33*SN*X1RØ-XC16))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*SN1RØ
      YDØT(I+4)  = R1*(YPRED(I+4)*CS*X1RØ+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
     1             +XN*YPRED(I+5)*X1RØ+(1.0/(XK33-
     1            XC16**2/XD33))*(YPRED(I)+YAMPT*(SN*X1RØ-XC16/XD33)))
      YDØT(I)    = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YANTH*SN*
     1             X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
     2             SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
     3             (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4             X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
     5             -R1*X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH*SN/RØ*
     6             (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5)  = YPRED(I+6)-R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+R1*
     1             (XD22*(YPRED(I+1)+K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-
     2             X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*
     3             (XK12*XD22+XC15*XC22)-(X1RØSQ*(XN*YPRED(I+4)-XNSQ*
     4             YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(XC22*XD12-XC15*XD22))
     5             /(XK22*XD22+XC22**2)
      EPSITH     = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH     = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1             X2*SAVY(6))
      YDØT(I+1)  = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1             YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2             -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3             (X1*XFZEL1+X2*XFZEL2))
     4             -R1*X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2)  = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1             +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2             (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3             XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4             -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5             (X1*SAVY(1)+X2*SAVY(4)))
     6             -R1*X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)-
     7             ATWØ*YAØPH))
      YDØT(I+3)  = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1             YAJPH+K*XMTHLD)
     2             +R1*X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)  = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7)  = R1*(XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*
     1             XNTPH)+X1RØ
     1*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*(XK12*XC22-XK22*XC15)
     2-(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*
     3(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)
      GØ TØ 9005
C     EQUATIØNS FØR CØNE
 7342 YANTH       = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)
     3 *SN)/(S*CS)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+((XN*YPRED(I+4)*SN-XNSQ*
     5 YPRED(I+6))/(S*S*CSSQ)+YPRED(I+7)/S)*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH       = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+(1.0/(S*S*CSSQ)*(-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*
     3 SN)+YPRED(I+7)/S)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+1.0/(S*CS)*(XN*YPRED(I+4)+
```

```
      5 YPRED(I+5)*CS-
      5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
      6 XD22*XK12))/(XC22*XC22+XK22*XD22))
       YAØPH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
       YAMPT =((XC16*TAN/S-XK33-(TAN/S)*(XD33*TAN/S-XC16))**(-1))*((XK33*
      1        XD33-XC16**2)*(1.0/(S*CS))*(-2.0*XN*YPRED(I+7)-YPRED(I+4)*
      2         SN/S+XN*YPRED(I+5)*TAN/S+2.0*XN*YPRED(I+6)/S)+YAØPH*SN*
      3         (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*TAN/S-XC16))
       YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
      1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
       YANPT     = YPRED(I)+YAMPT*TAN/S
       YDØT(I+4) = YPRED(I+4)/S+YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*
      1            YPRED(I+5)/(S*CS)+(1.0/(XK33-XC16**2/
      1             XD33))*(YPRED(I)+YAMPT*(TAN/S-XC16/XD33))
       YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
      1           +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
      2           (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
      3           TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
      4           +X2*SAVY(6)))
      5           -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+TN/S*
      6           (AØNE*YPRED(I+4)-ATWØ*YAØPH))
       YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
      1           +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-(XK12*
      1          XD22+XC15*XC22)*(1.0/(S*CS)*(XN*YPRED(I+4)+YPRED(I+5)*
      2          CS-YPRED(I+6)*SN))-(XC22*XD12-XC15*XD22)*((-XNSQ*
      3          YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+YPRED(I+7)/S))
      4          /(XK22*XD22+XC22*XC22)
       EPSITH    = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
      1            YPRED(I+6))
       EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
       YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
      1            (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
      2            XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
      3            -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
       YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
      1           -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
      2           -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
      3           (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
      4           X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
      5           -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/(S*CS)*(AØNE*YPRED(I+4)
      6           -ATWØ*YAØPH))
       YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
      1           *K
      2           +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
       YDØT(I+6)=YPRED(I+7)
       YDØT(I+7) = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)+
      1          (XK12*XC22-XK22*XC15)*(1.0/(S*CS)*(XN*YPRED(I+4)+
      2          YPRED(I+5)*CS-YPRED(I+6)*SN))-(XC15*XC22+XK22*XD12)*
      3          ((-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+
      4          YPRED(I+7)/S))/(XK22*XD22+XC22*XC22)
       GØ TØ 9005
C      EQUATIØNS FØR CYLINDER
 7343 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
      1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
      2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)-
      3 YPRED(I+6))*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
      4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)-XNSQ
      5 *YPRED(I+6)))*(-XC11+(XC15*XC15*XC22+
      6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
       YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
      1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
```

```
 2 XC22**2)-K*XMTTH+X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))
 3 *(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*
 4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)-
 5 YPRED(I+6))*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
 6 XD22*XK12))/(XC22*XC22+XK22*XD22))
  YAØPH     = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
  YAMPT=(1/(XC16*X1RØ-XK33-X1RØ*(XD33*X1RØ-XC16)))*((XK33*XD33-XC16
 1         **2)*X1RØ*(-2.0*XN*YPRED(I+7)+XN*X1RØ*YPRED(I+5))+YAØPH*
 2         (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*X1RØ-XC16))
  YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
 1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
  YANPT     = YPRED(I)+YAMPT*X1RØ
  YDØT(I+4) = (YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*YPRED(I+5)/RØ)+
 1            (1.0/(XK33-XC16**2/XD33))*(YPRED(I)+
 1           YAMPT*(X1RØ-XC16/XD33))
  YDØT(I)   = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
 1            -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
 2            X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
 3            (X1*SAVY(3)+X2*SAVY(6)))
 4            -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+1.0/RØ*
 5            (AØNE*YPRED(I+4)-ATWØ*YAØPH))
  YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
 1            +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-X1RØ*
 1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XD22+XC15*XC22)-X1RØSQ*(XN*YPRED
 2(I+4)-XNSQ*YPRED(I+6))*(XC22*XD12-XC15*XD22))/(XK22*XD22+XC22**2)
  EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
  EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
  YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
 1            EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
 2            X2*XFZEL2)
 3            -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
  YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
 1            XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
 2            YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
 3            (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
 4            -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)
 5            -ATWØ*YAØPH))
  YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
 1            +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
  YDØT(I+6)=YPRED(I+7)
  YDØT(I+7) = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)
 1            +X1RØ*
 1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XC22-XK22*XC15)-X1RØSQ*(XN*YPRED
 2(I+4)-XNSQ*YPRED(I+6))*(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)
9005 CØNTINUE
  RETURN
   END
```

SUBROUTINE SEGMAT

The results of the subroutine link, RIEMAN, are passed through the label common area, LYCORR, to this subroutine. SEGMAT places the elements of the YCORR array into several double-subscripted arrays, forms some coordinate transformation arrays, and calls subroutine SREVN2 for double precision matrix inversion.

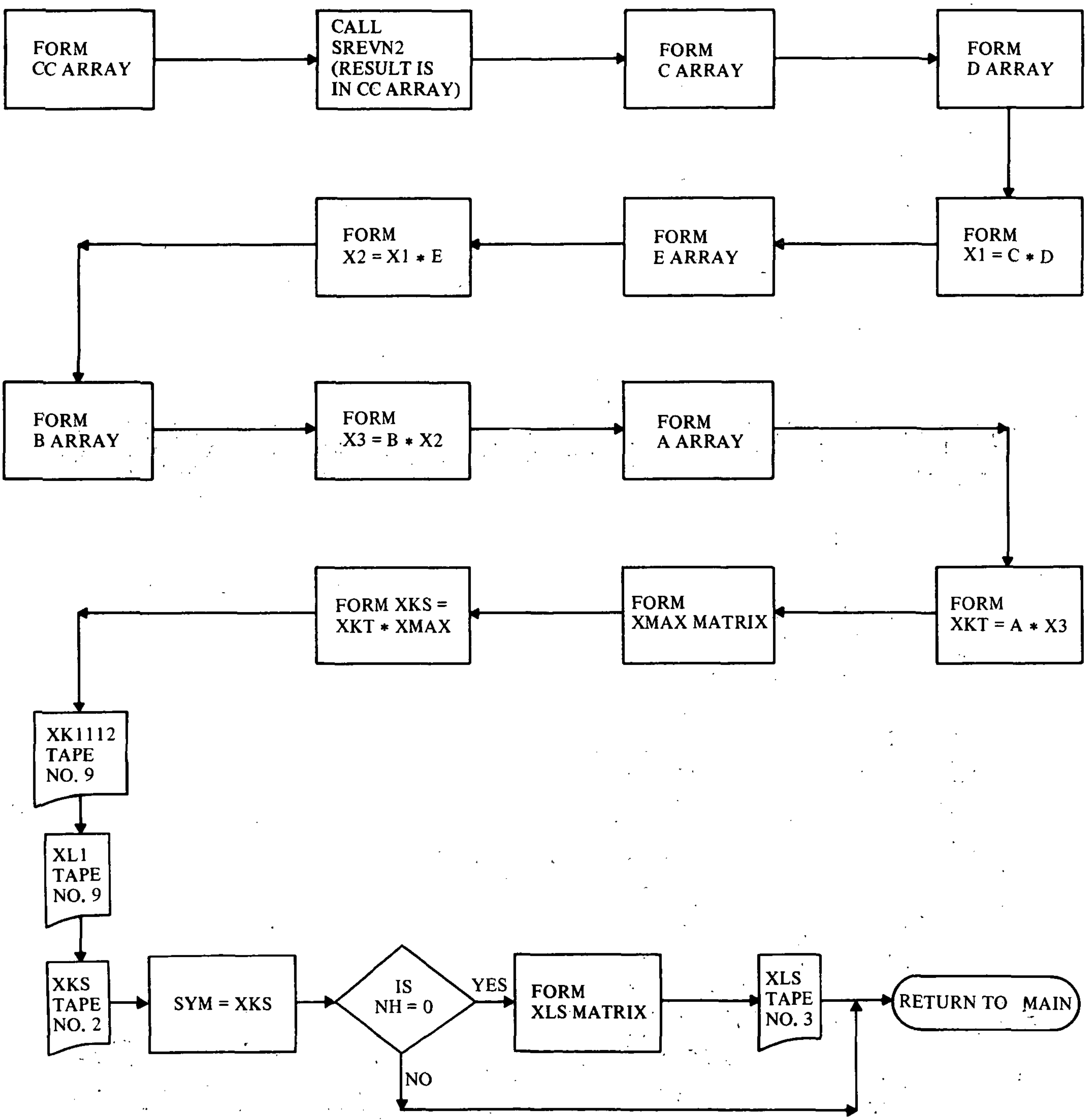
As a result of appropriate matrix operations this subroutine produces a segment stiffness matrix, the XKS array, and a segment load matrix, the XLS array, for each segment. In passes other than the first pass, first cycle, the XLS array is not calculated. SEGMAT also orients each segment into the global coordinate system of the structure as a result of the matrix operations.

Subroutine SREVN2

SREVN2 is a subroutine called by SEGMAT to invert a real, double-precision, in-core matrix utilizing Gauss-Jordan elimination with partial pivoting.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
SNI	si
SNJ	sj
CSI	ci
CSJ	cj
A MATRIX	$\left[\begin{array}{c\|c} IFT & 0 \\ \hline 0 & JFT \end{array}\right]$
B MATRIX	$\left[\begin{array}{c\|c\|c} 0 & I_4 & 0 \\ \hline X_1 & X_2 & X_3 \end{array}\right]$
C MATRIX	$\left[\begin{array}{c\|c\|c} I_4 & 0 & 0 \\ \hline 0 & Y_2^{-1} & 0 \\ \hline 0 & 0 & I_p \end{array}\right]$
D MATRIX	$\left[\begin{array}{c\|c\|c} I_4 & 0 & 0 \\ \hline -Y_1 & JDT^T & -Y_3 \\ \hline 0 & 0 & I_p \end{array}\right]$
E MATRIX	$\left[\begin{array}{c\|c\|c} IDT^T & 0 & 0 \\ \hline 0 & I_4 & 0 \\ \hline 0 & 0 & I_p \end{array}\right]$
XKT MATRIX	$\left[\begin{array}{c\|c} k & \ell \end{array}\right]$
XMAX MATRIX	$\left[\begin{array}{c\|c} 2\pi r_0(i) \ddots & \\ \hline & 2\pi r_0(j) \ddots \end{array}\right]$
XKS MATRIX	$_s\left[\hat{k}\right]^{(n)}$
XLS MATRIX	$_s\left[\hat{\ell}\right]^{(n)}$

SEGMAT


FORM CC ARRAY
CALL SREVN2 (RESULT IS IN CC ARRAY)
FORM C ARRAY
FORM D ARRAY
FORM X1 = C * D
FORM E ARRAY
FORM X2 = X1 * E
FORM B ARRAY
FORM X3 = B * X2
FORM A ARRAY
FORM XKT = A * X3
FORM XMAX MATRIX
FORM XKS = XKT * XMAX
XK1112 TAPE NO. 9
XL1 TAPE NO. 9
XKS TAPE NO. 2
SYM = XKS
IS NH = 0
YES
NO
FORM XLS MATRIX
XLS TAPE NO. 3
RETURN TO MAIN

```
FØR,IS SEGMAT,SEGMAT
      SUBRØUTINE SEGMAT
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK,YCØRR,A1
      DØUBLE PRECISIØN C,CC,D,E,B,A,X1,X2,X3,XKT,XMAX,XKS
      DØUBLE PRECISIØN RI,RJ,CSI,CSJ,SNI,SNJ,X2PIRI,X2PIRJ
      CØMMØN STØRY(16),XMAT(11C,1C),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /LYCØRR/ YCØRR(80)
      DIMENSIØN C(18,18),CC(4,4),D(18,18),E(18,18),B(8,18),A(8,8)
      DIMENSIØN X1(18,18),X2(18,18),X3(8,18),XKT(8,18),XMAX(8,18)
      DIMENSIØN XKS(8,18),XLS(8,2),SYM(8,18)
      DIMENSIØN  DEAD(4)
      DIMENSIØN LABEL(16)
      DIMENSIØN     N1(2)     ,N2(2)     ,N3(2)     ,N4(2)
      DIMENSIØN     N5(2)     ,N6(2)     ,N7(2)     ,N8(2)
      EQUIVALENCE (LABEL( 1),N1(1))    , (LABEL( 3),N2(1))
      EQUIVALENCE (LABEL( 5),N3(1))    , (LABEL( 7),N4(1))
      EQUIVALENCE (LABEL( 9),N5(1))    , (LABEL(11),N6(1))
      EQUIVALENCE (LABEL(13),N7(1))    , (LABEL(15),N8(1))
      EQUIVALENCE (C(1),E(1),X3(1),XMAX(1),XLS(1))
      EQUIVALENCE (X2(1),D(1),A(1),XKS(1)),(X1(1),B(1),XKT(1),SYM(1))
      SIN(X) = DSIN(X)
      CØS(X) = DCØS(X)
      DATA N1                 /8HFØRCE T1/
      DATA N2                 /8HFØRCE Z1/
      DATA N3                 /8HFØRCE R1/
      DATA N4                 /8HMØMENT 1/
      DATA N5                 /8HFØRCE T2/
      DATA N6                 /8HFØRCE Z2/
      DATA N7                 /8HFØRCE R2/
      DATA N8                 /8HMØMENT 2/
      IF (NH.EQ.0) WRITE(6,1726)
 1726 FØRMAT(1H1)
      A1=G1
      GØTØ (601,602,603),IGEØM
  601 SNI = SIN(TIC)
      SNJ = SIN(STØP)
      CSI = CØS(TIC)
      CSJ = CØS(STØP)
      GØTØ 1
  602 SNI = CØS(1.570796-A1)
      SNJ = SNI
      CSI = SIN(1.570796-A1)
      CSJ = CSI
      GØTØ 1
  603 SNI = 1.0
      SNJ = 1.C
      CSI = 0.0
      CSJ = 0.0
    1 JJ = 8+NPRØB
      DØ 111 J=1,18
      DØ 111 I=1,18
  111 C(I,J)=0.0
      K=28
```

```
      DØ 112 J=1,4
      K=K+8
      L=K
      DØ 112 I=1,4
      L=L+1
  112 CC(I,J)=YCØRR(L)
      CALL SREVN2 (CC,4,DEAD,4,NIX)
      IF (NIX.NE.0) GØTØ 8120
      J1=0
      DØ 113 J=5,8
      J1=J1+1
      II=0
      DØ 113 I=5,8
      II=II+1
  113 C(I,J)=CC(II,J1)
      DØ 114 IJ=1,4
  114 C(IJ,IJ)=1.0
      DØ 115 IJ=9,JJ
  115 C(IJ,IJ)=1.0
      DØ 116 J=1,18
      DØ 116 I=1,18
  116 D(I,J)=0.0
      DØ 117 IJ=1,4
  117 D(IJ,IJ)=1.0
      I=5
      D(I,I)=1.0
      D(I+1,I+1)=-SNJ
      D(I+2,I+2)=-SNJ
      D(I+3,I+3)=1.0
      D(I+1,I+2)= CSJ
      D(I+2,I+1)=-CSJ
      DØ 218 IJ=9,JJ
  218 D(IJ,IJ)=1.0
      K=-4
      DØ 118 J=1,4
      K=K+8
      L=K
      DØ 118 I=5,8
      L=L+1
  118 D(I,J)= -YCØRR(L)
      K=60
      DØ 119 J=9,JJ
      K=K+8
      L=K
      DØ 119 I=5,8
      L=L+1
  119 D(I,J)=-YCØRR(L)
      DØ 120 J=1,JJ
      DØ 120 I=1,JJ
      X1(I,J)=0.0
      DØ 120 M=1,JJ
  120 X1(I,J)=X1(I,J)+C(I,M)*D(M,J)
      DØ 121 J=1,18
      DØ 121 I=1,18
  121 E(I,J)=0.0
      I=1
      E(I,I)=1.0
      E(I+1,I+1)=-SNI
      E(I+2,I+2)=-SNI
      E(I+3,I+3)=1.0
      E(I+1,I+2)=CSI
```

```
      E(I+2,I+1)=-CSI
      DØ 122 J=5,JJ
  122 E(J,J)=1.0
      DØ 123 J=1,JJ
      DØ 123 I=1,JJ
      X2(I,J)=C.0
      DØ 123 M=1,JJ
  123 X2(I,J)=X2(I,J)+X1(I,M)*E(M,J)
      DØ 124 J=1,JJ
      DØ 124 I=1,8
  124 B(I,J)=0.0
      J=4
      DØ 125  I=1,4
      J=J+1
  125 B(I,J)=1.C
      K=-8
      DØ 126 J=1,4
      K=K+8
      L=K
      DØ 126 I=5,8
      L=L+1
  126 B(I,J)=YCØRR(L)
      K = 24
      DØ 127 J=5,8
      K=K+8
      L=K
      DØ 127 I=5,8
      L=L+1
  127 B(I,J)=YCØRR(L)
      K=56
      DØ 128 J=9,JJ
      K=K+8
      L=K
      DØ 128 I=5,8
      L=L+1
  128 B(I,J)=YCØRR(L)
      DØ 129 J=1,JJ
      DØ 129 I=1,8
      X3(I,J)=0.0
      DØ 129 M=1,JJ
  129 X3(I,J)=X3(I,J)+B(I,M)*X2(M,J)
      DØ 130 J=1,8
      DØ 130 I=1,8
  130 A(I,J)=0.0
      I=1
      A(I,I)=-1.0
      A(I+1,I+1)=SNI
      A(I+2,I+2)=SNI
      A(I+1,I+2)=CSI
      A(I+2,I+1)=-CSI
      A(I+3,I+3)=1.0
      I=5
      A(I,I)=1.0
      A(I+1,I+1)=-SNJ
      A(I+2,I+2)=-SNJ
      A(I+3,I+3)=-1.0
      A(I+1,I+2)=-CSJ
      A(I+2,I+1)=CSJ
      DØ 131 J=1,JJ
      DØ 131 I=1,8
      XKT(I,J)=0.0
```

```
      DØ 131 M=1,8
  131 XKT(I,J)=XKT(I,J)+A(I,M)*X3(M,J)
      PI=3.1415927
      RI=RTICK
      X2PIRI=2.0*PI*RI
      RJ=RESTØP
      X2PIRJ=2.0*PI*RJ
      DØ 132 J=1,8
      DØ 132 I=1,8
  132 XMAX(I,J)=0.0
      DØ 133 I=1,4
  133 XMAX(I,I)=X2PIRI
      DØ 134 J=5,8
  134 XMAX(J,J)=X2PIRJ
      DØ 135  J=1,JJ
      DØ 135 I=1,8
      XKS(I,J)=0.0
      DØ 135 M=1,8
  135 XKS(I,J)=XKS(I,J)+XMAX(I,M)*XKT(M,J)
      DØ 139 J=1,JJ
      DØ 139 I=1,4
  139 SYM(I,J) = XKT(I,J)
      WRITE(9) ((SYM(I,J),J=1,8),I=1,4),IGEØM,G1
      IF (NH.EQ.0) WRITE(9) ((SYM(I,J),J=9,JJ),I=1,4)
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,781)
  781 FØRMAT(//////55X,22HSTIFFNESS CØEFFICIENTS//14X,8HDELTA T1,7X,
     1 8HDELTA Z1,7X,8HDELTA R1,7X,7HTHETA 1,8X,8HDELTA T2,7X,8HDELTA Z2
     2 ,7X,8HDELTA R2,7X,7HTHETA 2)
      III=0
      DØ 20 M=1,8
      II =III+1
      III=II+1
      IF (NH.EQ.0.ØR.IBEGIN.EQ.1) WRITE(6,23) (LABEL(I),I=II,III),
     1                                  (XKS(M,J),J=1,8)
   23 FØRMAT(/1X,2A4,1X,8(E14.7,1X))
      DØ 20 J=1,8
      SYM(M,J) = XKS(M,J)
   20 CØNTINUE
 9968 FØRMAT(1H ,8(E14.7,2X)/(5X,8(E14.7,2X)))
      J1=8
      ISEG=0
      NRC1=NRC-1
      IF(NRC1.EQ.0)GØTØ 143
      DØ 244 I=1,NRC1
  244 ISEG=ISEG+NST(I)
  143 ISEG=ISEG+NSC
      SAVTIC(ISEG)=TIC
      WRITE(2) ((SYM(I,J),J=1,8),I=1,8)
      DØ 137 J=1,8
      DØ 137 I=1,8
  137 SYM(I,J)=0.0
      INDEC=0
      DØ 138 I=1,8
      DØ 138 J=1,8
      IF(J.NE.I)GØ TØ 138
      IF(XKS(I,J).GE.0.0)GØ TØ 138
      INDEC=1
  138 SYM(I,J)=XKS(I,J)
      IF(INDEC.EQ.0)GØ TØ 151
      IF (NH.NE.0) GØ TØ 151
      WRITE(6,152)
```

```
152 FØRMAT(7///- **********************************   WARNING - NEGATI
   1VES APPEAR ØN MAIN DIAGØNAL. REVISE SIZING   ****************-//)
151 JJ=2
    N  = 8
    J  = 1
    DØ 42  II=1,7
    M  = JJ
    DØ 43  I=M,N
    ALPH = ABS(SYM(I,J)) - ABS(SYM(J,I))
    IF(ALPH) 47,71,48
 47 IF(SYM(I,J).EQ.0.0) GØTØ 71
    SYM(I,J) = SYM(J,I) / SYM(I,J)
    GØTØ 43
 48 IF(SYM(J,I).EQ.0.0) GØTØ 71
    SYM(I,J) = SYM(I,J) / SYM(J,I)
    GØTØ 43
 71 SYM(I,J) = 1.0
 43 SYM(J,I) = 0.0
```

```
      JJ = JJ +1
      J = J+1
   42 CØNTINUE
      IF (NH.NE.O.AND.IBEGIN.NE.1) GØ TØ 145
      WRITE(6,785)
  785 FØRMAT(//55X,22HSEGMENT SYMMETRY CHECK,)
      DØ 144 I=1,8
  144 WRITE(6,9968)  (SYM(I,J),J=1,8)
  145 IF (NPRØB.EQ.0) GØ TØ 9999
      DØ 136 J=1,NPRØB
      J1=J1+1
      DØ 136 I=1,8
  136 XLS(I,J)=XKS( I,J1)
      WRITE(3)((XLS(I,J),J=1,NPRØB),I=1,8)
      WRITE (6,782)
  782 FØRMAT(//55X,22HSEGMENT LØAD MATRICES ,)
      DØ 840 I=1,8
  840 WRITE(6,9968)(XLS(I,J),J=1,NPRØB)
      GØTØ 9999
 8120 IERRØR=8120
      NERRØR=29
 8888 NIX=1
 9999 CØNTINUE
      IF (NH.EQ.O.ØR.IBEGIN.EQ.1) WRITE(6,795) RTICK,RESTØP
  795 FØRMAT(/- RZERØ(I) =-,1PE15.6,10X,-RZERØ(J) =-,1PE15.6)
      RETURN
       END
```

```
FØR,IS SREVN2,SREVN2
      SUBRØUTINE SREVN2(A,M,LØC,MID,NIX)
      DØUBLE PRECISIØN A(MID,1),PIVØT,TEMP1
      INTEGER LØC(1)
  100 N = M
      CØ 190  K = 1,N
      PIVØT = C.DO
      DØ 120  I = K,N
      IF (PIVØT - DABS(A(I,K))) 11C,110,120
  110 PIVØT = DABS(A(I,K))
      L = I
  120 CØNTINUE
      IF (PIVØT) 140,130,140
  130 NIX = -1
      GØ TØ 21C
  140 LØC(K) = L
      DØ 150  J = 1,N
      TEMP1 = A(K,J)
      A(K,J) = A(L,J)
  150 A(L,J) = TEMP1
      TEMP1 = A(K,K)
      A(K,K) = 1.DO
      DØ 160  J = 1,N
  160 A(K,J) = A(K,J)/TEMP1
      DØ 190  I = 1,N
      IF (I - K) 170,190,170
  170 TEMP1 = -A(I,K)
      A(I,K) = 0.DO
      DØ 180   J = 1,N
  180 A(I,J) = A(I,J) + TEMP1*A(K,J)
  190 CØNTINUE
      DØ 200  K = 1,N
      NK = N - K
      L = LØC(NK+1)
      DØ 200  I = 1,N
      TEMP1 = A(I,NK+1)
      A(I,NK+1) = A(I,L)
  200 A(I,L) = TEMP1
      NIX = 0
  210 RETURN
      END
```

SUBROUTINE REGMAT

The segment stiffness matrices, XKS, and the segment load matrices, XLS, are passed from SEGMAT to REGMAT via Tapes #2 and #3, and are placed in the XKRTOT array and the XLRTOT array, respectively. If kinematic links occur between segments in the region, the XKRTOT array and the XLRTOT array are modified to represent the situation. In the case of discrete rings the routine RINGER is called and provides the necessary matrices.

A horizontal and vertical partitioning of the XKRTOT array occurs while the XLRTOT array is subjected to a horizontal partitioning only. Appropriate matrix operations are performed upon the partitions of each array, thus reducing the size of the region stiffness and load matrices and resulting in increased program capacity. The results of these manipulations are the region stiffness matrix, XKR, and the region load matrix, XLR. In passes other than the first pass, first cycle, the load calculations are not performed

Subroutines Called from REGMAT

Subroutine SWITCH: Is a routine used to arrange a matrix in a form convenient for use by another routine employing a positive definite method for solving linear algebraic equations.

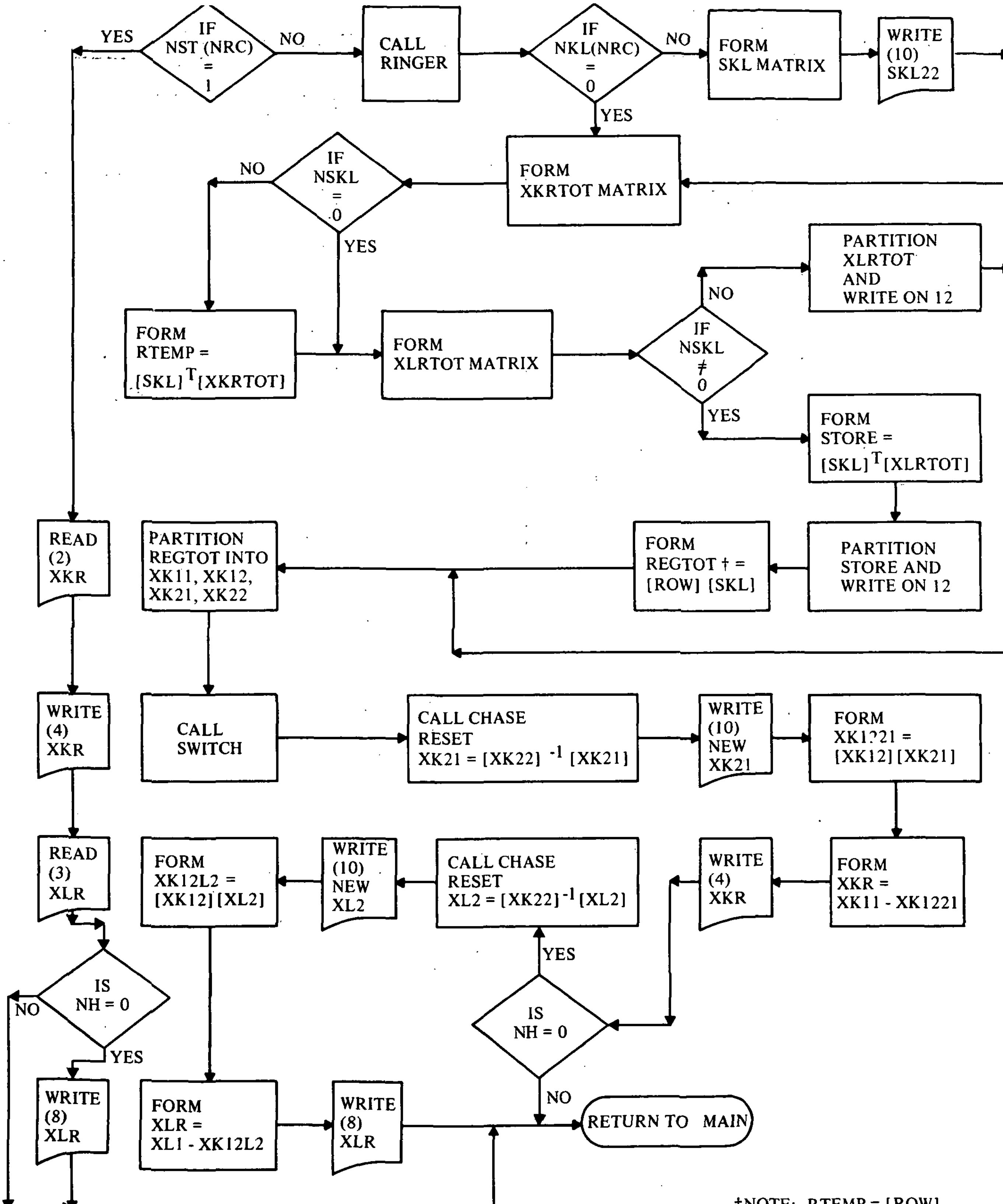
Subroutine CHASE: Is a routine used to obtain the solution X of the linear system AX = Y, given at least one right side of Y and the positive, definite, symmetric, real coefficient matrix A.

Subroutine FUTILE: Is a routine called from CHASE and used to obtain the factorization of the positive definite, real, symmetric matrix A into the product of a lower triangular matrix and its transpose by utilizing a Cholesky decomposition.

Subroutine TRIEQ: Is a routine called by CHASE or EIGVAL to solve a triangular system of algebraic equations.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
SKL MATRIX	$\left[SKL \right]$
SKLTR MATRIX	$\left[SKL \right]^T$
XKRTOT MATRIX	$\widehat{\left[\begin{array}{c\vert c} K'_{11} & K'_{12} \\ \hline K'_{21} & K'_{22} \end{array} \right]}$
XLRTOT MATRIX	$\widehat{\left[\begin{array}{c} L'_{iR1} \\ L'_{jR1} \\ \hline L' \end{array} \right]}$
SKL22 MATRIX	$\left[SKL_{22} \right]$
REGTOT MATRIX	$\widehat{\left[\begin{array}{c\vert c} K_{11} & K_{12} \\ \hline K_{21} & K_{22} \end{array} \right]}$
STORE MATRIX	$\widehat{\left[\begin{array}{c} L_{iR1} \\ L_{jR1} \\ \hline L \end{array} \right]}$
XK11 PARTITION	$\left[\hat{K}_{11} \right]$
XK12 PARTITION	$\left[\hat{K}_{12} \right]$
XK22 PARTITION	$\left[\hat{K}_{22} \right]$
XK21 PARTITION	$\left[\hat{K}_{21} \right]$

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
XL1 PARTITION	$\left[\hat{L}_{R1}\right]$
XL2 PARTITION	$\left[\hat{L}\right]$
XKR MATRIX	$\left[\hat{K}_R\right]$
XLR MATRIX	$\left[\hat{L}_R\right]$



†NOTE: RTEMP = [ROW]

```
FØR,IS REGMAT,REGMAT
      SUBRØUTINE REGMAT
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      CØMMØN STØRY(16),XMAT(11C,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(3C),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /ØPT2/ PRINT
      CØMMØN /ARING/ NRING(28),AMAT(30,4)
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      DIMENSIØN ØPEN(4,4)
      DIMENSIØN XTEMP(8,8),SKL(120,120),SKLTR(120)
      DIMENSIØN SYM(8,8)
      DIMENSIØN XKRTØT(120,120),RTEMP(120),XLRTØT(120,2),XKEEP(8,2)
      DIMENSIØN STØRE(120,2),RØW(12C),REGTØT(120),HØLC(4,120)
      DIMENSIØN XK22(112,112),XK11(8,8),XK12(8,112),XK21(112,8)
      DIMENSIØN XKIV(6328),XK1221(8,8),XKR(8,8)
      DIMENSIØN XL1(8,2),XL2(112,2),XK12L2(8,2),XLR(8,2)
      DIMENSIØN JDEP(112),JIND(15),ANGLE(15)
      DIMENSIØN RNGTØT(4,4),RNGLØC(4,28),JTNØ(28),RNLØD2(4,28)
      DIMENSIØN LABEL(16)
      DIMENSIØN     N1(2)     ,N2(2)     ,N3(2)     ,N4(2)
      DIMENSIØN     N5(2)     ,N6(2)     ,N7(2)     ,N8(2)
      EQUIVALENCE (SYM(1),XK12L2(1),XK1221(1),HØLD(1),JDEP(1))
      EQUIVALENCE (LABEL( 1),N1(1)),(LABEL( 3),N2(1))
      EQUIVALENCE (LABEL( 5),N3(1)),(LABEL( 7),N4(1))
      EQUIVALENCE (LABEL( 9),N5(1)),(LABEL(11),N6(1))
      EQUIVALENCE (LABEL(13),N7(1)),(LABEL(15),N8(1))
      EQUIVALENCE (SKL(1),XKRTØT(1),XK22(1),XKIV(1),XLRTØT(1))
      EQUIVALENCE (XKR(1),XK11(1),XTEMP(1),XLR(1),XL1(1),XKEEP(1),
     1            RTEMP(1),RØW(1))
      EQUIVALENCE (SKLTR(1),REGTØT(1),ØPEN(1),XK12(1))
      EQUIVALENCE (STØRE(1),XL2(1),XK21(1))
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DATA N1                 /8HFØRCE T1/
      DATA N2                 /8HFØRCE Z1/
      DATA N3                 /8HFØRCE R1/
      DATA N4                 /8HMØMENT 1/
      DATA N5                 /8HFØRCE T2/
      DATA N6                 /8HFØRCE Z2/
      DATA N7                 /8HFØRCE R2/
      DATA N8                 /8HMØMENT 2/
      REWIND 2
      REWIND 3
      REWIND 12
      D = 0.0
      PRINT = C.0
      NØJ = NST(NRC) + NKL(NRC) +1
      NØJ4 = NØJ*4
      NSKL = NKL(NRC)
      NH4=4
      NJTNH4=NH4*NØJ
      NJINK4 = (NØJ-NSKL)*4
      M8=NJINK4-8
      NKIV = NJINK4 - 8
      IF (NST(NRC).EQ.1) GØTØ 1
      IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 690
```

```
      WRITE(6,1726)
 1726 FØRMAT(1H1)
      WRITE(6,681) NRC,NØJ,NSKL
  681 FØRMAT(////51X31HINPUT DATA FØR SEGMENT CØUPLING///25X14HREGIØN NU
     1MBER ,I2,5X25HNUMBER ØF SEGMENT JØINTS ,I3,5X,26HNUMBER ØF KINEMAT
     2IC LINKS ,I3//)
      WRITE(6,682)
  682 FØRMAT(41X,7HSEGMENT,11X,8HJØINT(I),11X,8HJØINT(J)//)
      DØ 683 I=1,NSEG
      KTIC = SAVJTC(I)
      KSTØP= SAVSTP(I)
      WRITE(6,684) I,KTIC,KSTØP
  684 FØRMAT(43X,2(I3,16X),I3)
  683 CØNTINUE
  690 CØNTINUE
      NNT = NST(NRC)
      DØ 350 I=1,NØJ4
      DØ 350 J=1,NØJ4
  350 XKRTØT(I,J)=0.0
  591 FØRMAT (3I5,16A4)
      DØ 701 NS=1,NNT
      READ(2) ((XTEMP(I,J),J=1,8),I=1,8)
      J1 = SAVJTC(NS)
      J2 = SAVSTP(NS)
      II = 4*(J1-1)
       L = II
      IF (J1.GT.J2) GØTØ 950
      DØ 910  I = 1,8
       JJ = L
      II = II + 1
      DØ 910  J = 1,8
      JJ = JJ + 1
  910 XKRTØT(II,JJ)=XKRTØT(II,JJ)+XTEMP(I,J)
      GØTØ 701
  950 JJ = 4*(J2-1)+1
      II = II + 1
      DØ 960  JK = 1,4
      GØTØ (951,952,953,954) , JK
  951 IX = II
      IND = II
      DØ 961 I=1,4
      DØ 961 J=1,4
  961 ØPEN(I,J) = XTEMP(I,J)
      GØTØ 955
  952 IX = II
      IND = JJ
      DØ 962 I=1,4
      DØ 962 J=1,4
  962 ØPEN(I,J) = XTEMP(I,J+4)
      GØTØ 955
  953 IX = JJ
      IND = II
      DØ 963 I=1,4
      DØ 963 J=1,4
  963 ØPEN(I,J) = XTEMP(I+4,J)
      GØTØ 955
  954 IX = JJ
      IND = JJ
      DØ 964 I=1,4
      DØ 964 J=1,4
  964 ØPEN(I,J) = XTEMP(I+4,J+4)
```

```
955 DØ 956 I=1,4
    JX = IND
    DØ 957 J=1,4
    XKRTØT(IX,JX) = XKRTØT(IX,JX) + ØPEN(I,J)
957 JX = JX + 1
956 IX = IX + 1
960 CØNTINUE
701 CØNTINUE
    NRNG = NRING(NRC)
    IF (NRING(NRC).EQ.0) GØ TØ 210
    IF (Q.EQ.5) WRITE(6,300)
300 FØRMAT(///)
    MFLG = 1
    DØ 211 J=1,NRNG
    CALL RINGER (Q,XN,RNGTØT,RNGLØD,J,RADUS,TADUS,SAVJTC,SAVSTP,JTNØ,
   1             KBC,XNL,MFLG,NSEG,RNLØD2)
    JT = 4*(JTNØ(J)-1)
    DØ 220 I=1,4
    DØ 220 IK=1,4
220 XKRTØT(JT+I,JT+IK) = XKRTØT(JT+I,JT+IK)+RNGTØT(I,IK)
211 CØNTINUE
    IF (Q.NE.5) GØ TØ 210
    WRITE(6,300)
    READ(5,2000)
210 CØNTINUE
    REWIND  2
    IF(NSKL.NE.0) GØ TØ 931
    DØ 5504 I=1,NØJ4
    WRITE(2) (XKRTØT(I,J),J=1,NØJ4)
5504 CØNTINUE
    GØ TØ 101
931 CØNTINUE
    WRITE(12) ((XKRTØT(I,J),J=1,NØJ4),I=1,NØJ4)
    REWIND 12
    DØ 501 J=1,NJTNH4
    DØ 501 I=1,NJTNH4
501 SKL(I,J)=0.0
    IF (NH.EQ.0) WRITE(6,685)
685 FØRMAT(//60X13HSEGMENT LINKS//43X8HJØINT(J)5X8HJØINT(I)5X20HANGLE
   1ØF ØRIENTATIØN//)
    DØ 103  NRIG = 1,NSKL
    IF (Q.EQ.1) GØ TØ 566
    READ(5,503) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
503 FØRMAT (2I2,E14.7,15A4)
    WRITE(1) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
    WRITE(6,686) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
686 FØRMAT(45X,I3,10X,I3,11X,E14.7)
    IF(JIND(NRIG).GE.JDEP(NRIG)) GØ TØ 8797
    GØ TØ 103
566 READ(1) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)
103 CØNTINUE
    IF (Q.EQ.5) READ(5,2000)
2000 FØRMAT(1X)
    J = -3
    N = 1
    DØ 100  IJ = 1,NØJ
    I = 4*IJ-3
    IF(IJ.EQ.JDEP(N)) GØTØ 11
    J = J + 4
    GØTØ 12
 11 JD = JDEP(N)
```

```
      JI = JIND(N)
      CØTAN = CØS(ANGLE(N))/SIN(ANGLE(N))
      IF(N.LT.NRIG) N=N+1
      SKL(  I,   J) = RADUS(JD)/RADUS(JI)
      SKL(I+1,J+3) =-(RADUS(JD)-RADUS(JI))
      SKL(I+2,J+3) =-SKL(I+1,J+3)*CØTAN
      GØTØ 13
   12 SKL(  I,   J) = 1.0
   13 SKL(I+1,J+1) = 1.0
      SKL(I+2,J+2) = 1.0
      SKL(I+3,J+3) = 1.0
  100 CØNTINUE
 5000 FØRMAT(1H ,8(E14.7,2X)/(5X,8(E14.7,2X)))
      II = NØJ4 - 4
      JJ = NJINK4 - 4
      DØ 768 I=5,II
  768 WRITE(10) (SKL(I,J),J=5,JJ)
      DØ 702 J=1,NJINK4
  702 WRITE(2)  (SKL(I,J),I=1,NØJ4)
      WRITE(2) ((SKL(I,J),J=1,NJINK4),I=1,NØJ4)
      REWIND 2
      READ(12) ((XKRTØT(I,J),J=1,NØJ4),I=1,NØJ4)
      REWIND 12
 1000 CØNTINUE
      DØ 740 I=1,NJINK4
      READ(2) (SKLTR(J),J=1,NØJ4)
      DØ 741 J=1,NØJ4
      RTEMP   (J)=0.0
      DØ 741 K=1,NØJ4
  741 RTEMP   (J)=RTEMP   (J)+SKLTR(K)*XKRTØT(K,J)
      WRITE(12) (RTEMP   (J),J=1,NØJ4)
  740 CØNTINUE
      REWIND 12
  101 IF (NPRØB.EQ.0) GØ TØ 1001
      REWIND 2
      DØ 436 I=1,NØJ4
      DØ 436 J=1,NPRØB
  436 XLRTØT(I,J)=0.0
      DØ  971 NS = 1,NNT
      JTIC = SAVJTC(NS)
      JSTØP= SAVSTP(NS)
      READ (3) ((XKEEP(I,J),J=1,NPRØB),I=1,8)
      DØ  971 N =1,2
      GØTØ (981,982),N
  981 II = (JTIC-1)*4 + 1
      III= II + 3
      GØTØ 983
  982 II = (JSTØP-1)*4 +1
      III= II + 3
  983 DØ  971 J=1,NPRØB
      I =0
      IF (N.EQ.2) I=4
      DØ  971 IL = II,III
      I = I + 1
  971 XLRTØT(IL,J)= XLRTØT(IL,J)+ XKEEP(I,J)
      IF (NRNG.EQ.0) GØ TØ 230
      DØ 225 J=1,NRNG
      JT = 4*(JTNØ(J)-1)
      DØ 227 I=1,4
      DØ 226 IK=1,NPRØB
  226 XLRTØT(JT+I,IK) = XLRTØT(JT+I,IK)+RNGLØD(I,J)
```

```
      IF (IWØRD.GE.3) XLRTØT(JT+I,NPRØB) = XLRTØT(JT+I,NPRØB)+          902421
     1                RNLØD2(I,J)                                       902422
  227 CØNTINUE                                                          902423
  225 CØNTINUE                                                          902430
  230 CØNTINUE                                                          902440
      REWIND 3                                                          902450
      IF (NSKL.NE.0) GØTØ 147                                           902460
      DØ 119 I=1,4                                                      902470
  119 WRITE(3) (XLRTØT(I,J),J=1,NPRØB)                                  902480
      M3=NJINK4-3                                                       902490
      DØ 118 I=M3,NJINK4                                                902500
  118 WRITE(3) (XLRTØT(I,J),J=1,NPRØB)                                  902510
      M4=NJINK4-4                                                       902520
      DØ 117 I=5,M4                                                     902530
  117 WRITE(3) (XLRTØT(I,J),J=1,NPRØB)                                  902540
      REWIND 3                                                          902550
      GØTØ 102                                                          902560
  147 DØ 747  I=1,NJINK4                                                902570
      READ(2) (SKLTR(J),J=1,NØJ4)                                       902580
      DØ 748  J=1,NPRØB                                                 902590
      STØRE(I,J)=0.0                                                    902600
      DØ 748   K=1,NØJ4                                                 902610
  748 STØRE(I,J)=STØRE(I,J)+SKLTR(K)*XLRTØT(K,J)                        902620
  747 CØNTINUE                                                          902630
      DØ 919 I=1,4                                                      902640
  919 WRITE(3) (STØRE(I,J),J=1,NPRØB)                                   902650
      M3=NJINK4-3                                                       902660
      DØ 918 I=M3,NJINK4                                                902670
  918 WRITE(3) (STØRE(I,J),J=1,NPRØB)                                   902680
      M4=NJINK4-4                                                       902690
      DØ 917 I=5,M4                                                     902700
  917 WRITE(3) (STØRE(I,J),J=1,NPRØB)                                   902710
      REWIND 3                                                          902720
 1001 CØNTINUE                                                          902730
      IF (NSKL.EQ.0) GØ TØ 102                                          902740
      READ(2) ((SKL(I,J),J=1,NJINK4),I=1,NØJ4)                          902750
      REWIND 2                                                          902760
      DØ 750 I=1,NJINK4                                                 902770
      READ(12) (RØW(J),J=1,NØJ4)                                        902780
      DØ 751 J=1,NJINK4                                                 902790
      REGTØT  (J)=0.0                                                   902800
      DØ 751 K=1,NØJ4                                                   902810
  751 REGTØT  (J)=REGTØT  (J)  +  RØW(K)*SKL(K,J)                       902820
  750 WRITE(2) (REGTØT(J),J=1,NJINK4)                                   902830
C     THE 780 LØØP REARRANGES AND PARTITIØNS THE REGIØN STIFFNESS MATRIX 902840
  102 NJINK = NJINK4/4                                                  902850
      REWIND 2                                                          902860
      DØ 625 INK=1,8                                                    902870
      DØ 626 JAK=1,8                                                    902880
  626 XK11(INK,JAK)=0.0                                                 902890
      DØ 625 KIX=1,M8                                                   902900
      XK12(INK,KIX)=0.0                                                 902910
      XK21(KIX,INK)=0.0                                                 902920
  625 CØNTINUE                                                          902930
      DØ 627 KIX=1,M8                                                   902940
      DØ 627 LAX=1,M8                                                   902950
  627 XK22(KIX,LAX)=0.0                                                 902960
      NREAD=0                                                           902970
      KØUNT=-8                                                          902980
      NJINK3=NJINK-1                                                    902990
      DØ 780 N=1,NJINK                                                  903000
```

```
      NREAD=NREAD+1
      KØUNT=KØUNT+4
      DØ 781 I=1,4
  781 READ(2)  (HØLD(I,J),J=1,NJINK4)
      IF(NREAD.LE.2.ØR.NREAD.GE.NJINK3)GØ TØ 790
      KK=KØUNT+1
      KKK=KØUNT+12
      DØ 785 L=KK,KKK
      IRØW=4*(NREAD-2)
      J=L-4
      DØ 785 K=1,4
      IRØW=IRØW+1
  785 XK22(IRØW,J)=HØLD(K,L)
      GØ TØ 780
  790 IF(NREAD.EQ.1)GØ TØ 791
      IF(NREAD.EQ.2)GØ TØ 792
      IF(NREAD.EQ.NJINK3)GØ TØ 793
      IF(NREAD.EQ.NJINK)GØ TØ 794
  791 DØ 796 I=1,4
      DØ 796 J=1,4
      XK11(I,J)=HØLD(I,J)
      JJ=J+4
  796 XK12(I,J)=HØLD(I,JJ)
      GØ TØ 780
  792 DØ 797 I=1,4
      DØ 797 J=1,4
      XK21(I,J)=HØLD(I,J)
      JJ=J+4
      XK22(I,J)=HØLD(I,JJ)
      JJJ=J+8
      IF(NNT.EQ.2)  GØ TØ 795
      XK22(I,JJ)=HØLD(I,JJJ)
       GØ TØ 797
  795 XK21(I,JJ)=HØLD(I,JJJ)
  797 CØNTINUE
      GØ TØ 780
  793 M11=NJINK4-11
      M4=NJINK4-4
      M8=NJINK4-8
      KRØW=M8-4
      DØ 798 I=1,4
      KRØW=KRØW+1
      KCØL=4
      K8=M8-8
      DØ 798 J=M11,M8
      K8=K8+1
      XK22(KRØW,K8)=HØLD(I,J)
      JJ=J+4
      KK=K8+4
      XK22(KRØW,KK)  =HØLD(I,JJ)
      JJJ=J+8
      KCØL=KCØL+1
  798 XK21(KRØW,KCØL)=HØLD(I,JJJ)
      GØ TØ 78C
  794 KEND=NJINK4-8
      KRØW=4
      M4=NJINK4-4
      M7=NJINK4-7
      DØ 799 I=1,4
      KRØW=KRØW+1
      K4=KEND-4
```

```
      KCØL=4
      DØ 799 J=M7,M4
      K4=K4+1
      XK12(KRØW,K4)=HØLD(I,J)
      KCØL=KCØL+1
      JJ=J+4
  799 XK11(KRØW,KCØL)=HØLD(I,JJ)
  780 CØNTINUE
 7703 NSING=NKIV*(NKIV+1)/2
      N=NKIV
      IK=1
      DØ 10 K=1,N
      DØ 10 I=K,N
      XK22(I,K)=(XK22(I,K)+ XK22(K,I))/2.
      XKIV(IK)=XK22(I,K)
   10 IK=IK+1
      CALL SWITCH (XKIV,-NKIV)
      CALL CHASE (XKIV,NKIV,XK21,8,112,NIX)
      IF (NIX.LT.0) GØTØ 8841
      WRITE (10) ((XK21(I,J),J=1,8),I=1,M8    )
      WRITE (10)(( SAVJTC(I), SAVSTP(I)),I=1,NNT)
      DØ 81 J=1,8
      DØ 81 I=1,8
      XK1221(I,J)=0.0
      DØ 81 K=1,NKIV
   81 XK1221(I,J)=XK1221(I,J)+XK12(I,K)*XK21(K,J)
      DØ 82 J=1,8
      DØ 82 I=1,8
   82 XKR(I,J)=XK11(I,J)-XK1221(I,J)
      DØ 650 J=1,7
      K = J+1
      DØ 650 I=K,8
      XKR(I,J) = (XKR(I,J)+XKR(J,I))/2.0
  650 XKR(J,I) = XKR(I,J)
      WRITE (4) ((XKR(I,J),J=1,8),I=1,8)
      IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 691
      WRITE(6,5011)
 5011 FØRMAT(////55X23HREGIØN STIFFNESS MATRIX//14X8HDELTA T17X8HDELTA Z
     11,7X,8HDELTA R1,7X,7HTHETA 1,8X,8HDELTA T2,7X,8HDELTA Z2,7X,8HDELT
     2A R2,7X,7HTHETA 2)
      III=0
      DØ 687 M=1,8
      II=III+1
      III=II+1
      WRITE(6,688)  (LABEL(I),I=II,III),(XKR(M,J),J=1,8)
  688 FØRMAT(/1X,2A4,1X,8(E14.7,1X))
  687 CØNTINUE
  691 CØNTINUE
      DØ 137 J=1,8
      DØ 137 I=1,8
  137 SYM(I,J)=0.0
      INDEC=0
      DØ 138 I=1,8
      DØ 138 J=1,8
      IF(J.NE.1)GØ TØ 138
      IF(XKR(I,J).GE.0.0)GØ TØ 138
      INDEC=1
  138 SYM(I,J)=XKR(I,J)
      IF(INDEC.EQ.0)GØ TØ 151
      IF (NH.NE.0) GØ TØ 151
      WRITE(6,152)
```

```
  152 FØRMAT(////- ***********************************   WARNING - NEGATI
     1VES APPEAR ØN MAIN DIAGØNAL. REVISE SIZING   ****************-//)
  151 JJ=2
      N  = 8
      J  = 1
      DØ 42  II=1,7
      M  = JJ
      DØ 43  I=M,N
      ALPH = ABS(SYM(I,J)) - ABS(SYM(J,I))
      IF(ALPH) 47,71,48
   47 IF(SYM(I,J).EQ.0.0) GØTØ 71
      SYM(I,J) = SYM(J,I) / SYM(I,J)
      GØTØ 43
   48 IF(SYM(J,I).EQ.0.0) GØTØ 71
      SYM(I,J) = SYM(I,J) / SYM(J,I)
      GØTØ 43
   71 SYM(I,J) = 1.0
   43 SYM(J,I) = 0.0
      JJ = JJ +1
      J = J+1
   42 CØNTINUE
      IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 692
      WRITE(6,157)
  157 FØRMAT(//56X,21HREGIØN SYMMETRY CHECK/)
      DØ 1730 I=1,8
      WRITE(6,5000) (SYM(I,J),J=1,8)
 1730 CØNTINUE
  692 CØNTINUE
      IF (NPRØB.EQ.0) GØ TØ 150
      DØ 819 I=1,4
  819 READ(3)  (XL1(I,J),J=1,NPRØB)
      DØ 818 I=5,8
  818 READ(3)  (XL1(I,J),J=1,NPRØB)
      D = 0.0
      M8 = NJINK4-8
      DØ 817 I=1,M8
  817 READ(3)  (XL2(I,J),J=1,NPRØB)
      CALL CHASE (XKIV,NKIV,XL2,-NPRØB,112,NIX)
      IF (NIX.LT.0) GØTØ 8842
      WRITE (10) ((XL2(I,J),J=1,NPRØB),I=1,M8   )
      NL2=NPRØB
      DØ 205  J=1,NPRØB
      DØ 205  I=1,8
      XK12L2(I,J)=0.0
      DØ 205  K=1,NKIV
  205 XK12L2(I,J)=XK12L2(I,J)+XK12(I,K)*XL2(K,J)
      DØ 206  J=1,NPRØB
      DØ 206  I=1,8
  206 XLR(I,J)=XL1(I,J)-XK12L2(I,J)
      WRITE(8) ((XLR(I,J),J=1,NPRØB),I=1,8)
      IF (NH.NE.0.AND.IBEGIN.NE.1) GØ TØ 150
      WRITE(6,5012)
 5012 FØRMAT(//57X,18HREGIØN LØAD MATRIX/)
      DØ 5512 I=1,8
 5512 WRITE(6,5000)  (XLR(I,J),J=1,NPRØB)
      GØTØ 150
 8841 IERRØR=8841
      NERRØR=30
      GØTØ 150
 8797 IERRØR = 8797
      NERRØR=33
```

```
      GØ TØ 150
 8842 IERRØR=8842
      NERRØR=31
      GØTØ 150
    1 READ (2) ((XKR(I,J),J=1,8),I=1,8)
      DØ 651 J=1,7
      K = J+1
      DØ 651 I=K,8
      XKR(I,J) = (XKR(I,J)+XKR(J,I))/2.0
  651 XKR(J,I) = XKR(I,J)
      WRITE(4) ((XKR(I,J),J=1,8),I=1,8)
      IF (NPRØB.EQ.0) GØ TØ 150
      READ(3)  ((XLR(I,J),J=1,NPRØB),I=1,8)
      WRITE(8) ((XLR(I,J),J=1,NPRØB),I=1,8)
  150 RETURN
       END
```

```
FØR,IS SWITCH,SWITCH
      SUBRØUTINE SWITCH(A,M)
      DIMENSIØN A(1)
      N = IABS(M)
      IF (N - 2) 190,190,90
   90 L = (N*(N+1)) / 2
      KEY = 1
      LØCK = N/2 + 1
      IF (M) 100,190,160
  100 IF (N - 3) 110,140,110
  110 KKT = 3
      NKF = N - 1
      IMAGE = L
      INTØ = L - 3
      I = 3
      DØ 130  K = 2,LØCK
      DØ 120  IK = KKT,NKF
      X = A(IK)
      A(IK) = A(INTØ)
      A(INTØ) = X
      INTØ = INTØ - I
  120 I = I + 1
      KKT = NKF + K
      NKF = NKF + N - K
      IMAGE = IMAGE - K
      INTØ = IMAGE
  130 I = K
  140 IF (KEY) 150,190,150
  150 KEY = 0
  160 LØV2 = L / 2
      K = L - 2
      DØ 170  I = 3,LØV2
      X = A(I)
      A(I) = A(K)
      A(K) = X
  170 K = K - 1
      IF (KEY) 180,190,180
  180 KEY = 0
      GØ TØ 100
  190 RETURN
       END
```

```
FØR,IS CHASE,CHASE
      SUBRØUTINE CHASE(A,MO,Y,NO,MID,NIX)
      REAL A(1),Y(1)
      CØMMØN /WINTER/ INDIC8
      CØMMØN /BØND/ M,L
      CØMMØN /ØPT2/ PRINT
    9 FØRMAT(12H1SØLUTIØN(S)/1H0)
   10 FØRMAT(I5,1P8E15.7/(5X,8E15.7))
      M=MO
      INDIC8=0
      N = IABS(NO)
      IF (NO) 110,100,100
  100 CALL FUTILE(A,M,NIX)
      IF (NIX) 170,110,110
  110 PRINT = 0.0
      IF (PRINT .GT. 0.0)  WRITE(6,9)
      MK1 = 1
      L = 1
      I1 = M
      DØ 160  K = 1,N
      CALL TRIEQ(A,Y(MK1))
      IF (PRINT .GT. 0.) WRITE (6,10) K,(Y(K1), K1 = MK1,I1)
      I1 = I1 + MID
      MK1 = MK1 + MID
  160 CØNTINUE
  170 RETURN
      END
```

```
FØR,IS FUTILE,FUTILE
      SUBRØUTINE FUTILE(A,N,NIX)
      DIMENSIØN A(1)
      DØUBLE PRECISIØN SUM
      EQUIVALENCE (SUN,SUM)
      K1 = 1
      KK = 0
      DØ 210  K = 1,N
      KK = KK + K
      IK = KK
      KK1 = KK - 1
      IF (KK1) 60,50,60
   50 ASSIGN 100 TØ LEAP
      GØ TØ 70
   60 ASSIGN  8C TØ LEAP
   70 I1 = K1
      DØ 140  I = K,N
      SUM = -A(IK)
      GØ TØ LEAP, (80,100)
   80 IJ = I1
      DØ 90 KJ = K1,KK1
      SUM = SUM + A(IJ)*A(KJ)
   90 IJ = IJ + 1
  100 I1 = I1 + I
      IF (I - K) 12C,105,120
  105 DENØM = -SUM
      IF (DENØM) 980,98C,110
  110 DENØM = -SQRT(DENØM)
      A(IK) = -DENØM
      GØ TØ 13C
  120 A(IK) = SUM / DENØM
  130 IK = IK + I
  140 CØNTINUE
      K1 = K1 + K
  210 CØNTINUE
      NIX = 0
  220 RETURN
  980 NIX = -K
      GØ TØ 220
       END
```

```
FØR,IS TRIEQ,TRIEQ
      SUBRØUTINE TRIEQ(A,Y)
      REAL A(1),Y(1)
      CØMMØN /WINTER/INDIC8
      CØMMØN /BØND/ M,L
      DØUBLE PRECISIØN SUM
      EQUIVALENCE (SUN,SUM)
      L1 = L
      MM1 = M - 1
      MML = M - L1
      IF (INDIC8) 130,100,100
  100 Y(L1) = Y(L1) / A(L1)
      I1 = L1
      II = I1
      IF (MML) 105,125,105
  105 DØ 120  I = L1,MM1
      I1 = I1 + 1
      SUM = -Y(I+1)
      IJ = I1
      DØ 110  J = L1,I
      SUM = SUM + A(IJ)*Y(J)
  110 IJ = IJ + 1
      II = IJ
  120 Y(I+1) = -SUM / A(II)
  125 IF (INDIC8) 170,140,170
  130 II = ( ( MML + 1 ) * ( M + L1 ) )  /  2
  140 I = M
  145 Y(I) = Y(I) / A(II)
      II = II - 1
      I = I - 1
      IF (I - L1) 170,150,150
  150 SUN = -Y(I+1)
      IJ = II + L1
      DØ 160  J = L1,I
      Y(J) = Y(J) + SUN*A(IJ)
  160 IJ = IJ + 1
      GØ TØ 145
  170 RETURN
       END
```

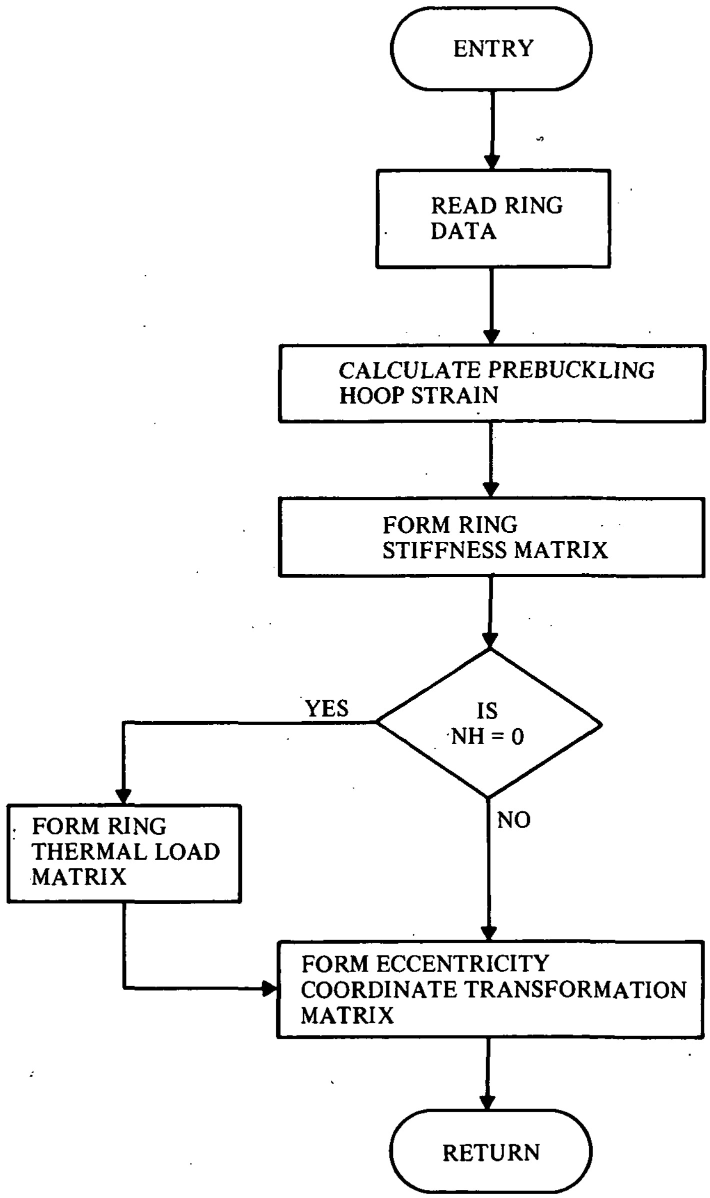
SUBROUTINE RINGER

This subroutine reads the discrete ring geometric data, and temperatures, and forms the ring stiffness, mass, and thermal load matrices. These matrices are passed back to either of subroutines REGMAT or STRMAT (see next) as necessary, for incorporation into the region or structure matrices, respectively. The effects of static prestress are considered, and the load calculations are omitted in passes involving eigenvalue extractions.

The calculations in RINGER account for the eccentricity of the ring centroid from the base shell wall, and the offset of the ring centroid from the shear center.

FORTRAN CODE	ENGINEERING SYMOBLS (REF. 1)
RNGTOT MATRIX	$\left[k_R\right]$
TDEL MATRIX	$\left[T_{\Delta}\right]$
RNGLOD MATRIX	$\left[\ell_R\right]$
RC	r_c
RS	r_s
XC	x_c
YC	x_s

RINGER



ENTRY
READ RING DATA
CALCULATE PREBUCKLING HOOP STRAIN
FORM RING STIFFNESS MATRIX
IS NH = 0
YES
NO
FORM RING THERMAL LOAD MATRIX
FORM ECCENTRICITY COORDINATE TRANSFORMATION MATRIX
RETURN

```
FØR,IS RINGER,RINGER
      SUBRØUTINE RINGER (Q,XN,RNGTØT,RNGLØD,J,ADUS,BADUS,JTIC,JSTØP,       3300010
     1                   JTNØ,KBC,XNL,MFLG,NSEG,RNLØD2)                    3300020
      INTEGER Q,XN                                                         3300030
      CØMMØN /ARING/ NRING(28),AMAT(30,4)                                  3300040
      CØMMØN /PLS/ ØMEGA,IWØRD                                             3300041
      DIMENSIØN RNGTØT(4,4),RNGLØD(4,28),TDEL(4,4),XKTØT(4,4),XL(4)        3300050
      DIMENSIØN ADUS(30),BADUS(30),JTIC(30),JSTØP(30),JTNØ(28),XNL(3)      3300060
      DIMENSIØN RNLØD2(4,28)                                               3300061
      X1 = XNL(1)                                                          3300070
      X2 = XNL(2)                                                          3300080
      X3 = XNL(3)                                                          3300081
      IF (Q.EQ.1) GØ TØ 212                                                3300090
      READ(5,213) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,XI,   3300100
     1           XØ,TI,TØ,TF,RØJ,RHØ,E                                     3300140
  213 FØRMAT(I2,5E14.7/6E12.5/5E14.7/3E14.7)                               3300150
      AMN = (TI-TØ)/(XI-XØ)                                                3300130
      BN = ((TØ-TF)*XI-(TI-TF)*XØ)/(XI-XØ)                                 3300140
      WRITE(1) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,         3300150
     1          AMN,BN,RØJ,RHØ,E                                           3300190
      WRITE(6,300) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,     3300170
     1             XI,XØ,TI,TØ,TF,RØJ,RHØ,E                                3300210
  300 FØRMAT(/55X,-RING AT JØINT NØ. -,I2//- EA =-,1PE12.5,6X,-EIY =-,    3300190
     1 1PE12.5,5X,-EIXY =-,1PE12.5,4X,-GJ =-,1PE12.5,6X,-EIX =-,1PE12.5,   3300200
     2 5X,-ALPR =-,1PE12.5/- RC =-,1PE12.5,6X,-XC =-,1PE12.5,6X,-YC =-,    3300210
     3 1PE12.5,6X,-XBAR =-,1PE12.5,4X,-YBAR =-,1PE12.5,4X,-XI =-,          3300220
     4 1PE12.5/- XØ =-,1PE12.5,6X,-TI =-,1PE12.5,6X,-TØ =-,1PE12.5,6X,     3300230
     5 -TFREE =-,1PE12.5,3X,-RØ =-,1PE12.5,6X,-RHØ =-,1PE12.5/             3300270
     6 - E =-,1PE12.5)                                                     3300280
      GØ TØ 211                                                            3300250
  212 READ(1) JTNØ(J),EA,EIY,EIXY,GJ,EIX,ALPR,RC,XC,YC,XBAR,YBAR,          3300260
     1         AMN,BN,RØJ,RHØ,E                                            3300310
  211 CØNTINUE                                                             3300280
  100 K = JTNØ(J)                                                          3300290
      IF (MFLG.EQ.2) GØ TØ 102                                             3300300
      EPSIL1 = AMAT(K,1)                                                   3300350
      EPSIL2 = AMAT(K,2)                                                   3300360
      GØ TØ 101                                                            3300330
  102 EPSIL1 = AMAT(K,3)                                                   3300380
      EPSIL2 = AMAT(K,4)                                                   3300390
  101 CØNTINUE                                                             3300360
      A = EA/E
      Y = EIY/E
      X = EIX/E
      XY = EIXY/E
      RØM = RHØ*ØMEGA
      RS = RC+XC                                                           3300370
      AM = XN                                                              3300380
      AM2 = AM*AM                                                          3300390
      AM4 = AM2*AM2                                                        3300400
      RCS = RC*RS                                                          3300410
      RC2 = RC*RC                                                          3300420
      RS2 = RS*RS                                                          3300430
      RS3 = RS2*RS                                                         3300440
      RCS3 = RCS*RS2                                                       3300450
      XC2 = XC*XC                                                          3300460
      YC2 = YC*YC                                                          3300470
      TWØPI = 2.0*3.1415927                                                3300480
      IF (IWØRD.EQ.3.ØR.IWØRD.EQ.5) EPSIL2 = EPSIL1                        3300571
      EPSIL = (X1*EPSIL1+X2*EPSIL2)*RC/RØJ                                 3300580
      EAPS = EA*EPSIL                                                      3300500
```

```
      RNGTØT(1,1) = 1.0/RCS*(EA*(XC2*AM4/RS2-2.0*XC*AM2/RS+1.0)+           3300510
     1              EIY/RC2*(AM4-2.0*AM2+1.0))                             3300520
     2              +EAPS*AM2*RC/RS3                                       3300530
     3              -EAPS*RC/RS3                                           3300621
     3              -RØM*(A+Y/RC2*AM2)*X3                                  3300531
      RNGTØT(2,1) = 1.0/RCS*(EA*YC*AM2*(XC*AM2/RS2-1.0/RS)+EIY*YC*AM2/     3300540
     1              (RC2*RS)*(AM2-1.0)+EIXY*AM2/RCS*(AM2-1.0))             3300550
     3              -RØM*XY/RC2*AM2*X3                                     3300561
      RNGTØT(3,1) = EA*AM/RS2*(-XC*AM2/RS+1.0)                             3300570
     2              -RØM*Y/RC2*AM*X3                                       3300581
      RNGTØT(4,1) = 1.0/RCS*(EA*YC*(XC*AM2/RS-1.0)+EIY*YC/RC2*             3300590
     1              (AM2-1.0)+EIXY/RC*(AM2-1.0))                           3300600
     2              -EAPS*AM2*YC/RS2                                       3300610
     3              +EAPS*YC/RS2                                           3300731
      RNGTØT(1,2) = RNGTØT(2,1)                                            3300620
      RNGTØT(2,2) = AM4/RCS3*(EA*YC2+EIY*YC2/RC2+EIX+2.0*EIXY*YC/RC)+      3300750
     1              GJ*AM2/(RS2*RS2)                                       3300640
     2              +AM2/RCS*EAPS                                          3300770
     3              -RØM*(A+X/RC2*AM2)*X3                                  3300651
      RNGTØT(3,2) = -EA*YC*AM2*AM/(RS2*RS)                                 3300660
     2              -RØM*XY/RC2*AM*X3                                      3300671
      RNGTØT(4,2) = AM2/(RS2*RC)*(YC2*(EA+EIY/RC2)+EIX+2.0*EIXY*YC/RC      3300680
     1              +GJ*RC/RS)                                             3300690
     2              +AM2/RCS*EAPS*XC                                       3300840
      RNGTØT(1,3) = RNGTØT(3,1)                                            3300710
      RNGTØT(2,3) = RNGTØT(3,2)                                            3300720
      RNGTØT(3,3) = EA*AM2*RC/(RS2*RS)                                     3300730
     2              -RØM*(A+Y/RC2)*X3                                      3300741
      RNGTØT(4,3) = -EA*YC*AM/RS2                                          3300750
      RNGTØT(1,4) = RNGTØT(4,1)                                            3300770
      RNGTØT(2,4) = RNGTØT(4,2)                                            3300780
      RNGTØT(3,4) = RNGTØT(4,3)                                            3300790
      RNGTØT(4,4) = 1.0/RCS*(YC2* EA+EIY*YC/RC+EIX+2.0*EIXY*YC/RC)+         330085
     1              GJ*AM2/RS2                                             3300810
     2              +1.0/RCS*EPSIL*(EA*(-YC2)+(EIY+EIX)*AM2-EIX)           3300970
     3              -RØM*(X+Y)*X3                                          3300821
      IF (Q.EQ.1) GØ TØ 400                                                3300830
      TEM1 = EA*ALPR*(AMN*XC+BN)/RS                                        3300840
      RNGLØD(1,J) = TEM1                                                   3300850
      RNGLØD(2,J) = 0.0                                                    3300860
      RNGLØD(3,J) = 0.0                                                    3300870
      RNGLØD(4,J) = -TEM1*YC-EIXY*ALPR*AMN/RS                              3300880
  400 CØNTINUE                                                             3300890
      XBRS = 1.0-XBAR/RS                                                   3300900
      TDEL(1,1) = 0.0                                                      3300910
      TDEL(2,1) = 0.0                                                      3300920
      TDEL(3,1) = -1.0/XBRS                                                3300930
      TDEL(4,1) = 0.0                                                      3300940
      TDEL(1,2) = 0.0                                                      3300950
      TDEL(2,2) = -1.0                                                     3300960
      TDEL(3,2) = -AM*YBAR/(RS*XBRS)                                       3300970
      TDEL(4,2) = 0.0                                                      3300980
      TDEL(1,3) = -1.0                                                     3300990
      TDEL(2,3) = 0.0                                                      3301000
      TDEL(3,3) = -AM*XBAR/(RS*XBRS)                                       3301010
      TDEL(4,3) = 0.0                                                      3301020
      TDEL(1,4) = -YBAR                                                    3301030
      TDEL(2,4) = +XBAR                                                    3301040
      TDEL(3,4) = 0.0                                                      3301050
      TDEL(4,4) = -1.0                                                     3301060
      DØ 813 L=1,4                                                         3301070
```

```
      DØ 813 M=1,4
      XKTØT(L,M) = 0.0
      DØ 813 N=1,4
  813 XKTØT(L,M) = XKTØT(L,M)+RNGTØT(L,N)*TDEL(N,M)
      DØ 814 L=1,4
      DØ 814 M=1,4
      RNGTØT(L,M) = 0.0
      DØ 814 N=1,4
  814 RNGTØT(L,M) = RNGTØT(L,M)+TDEL(N,L)*XKTØT(N,M)
      IF (Q.EQ.1) GØ TØ 401
      DØ 815 L=1,4
      XL(L) = 0.0
      DØ 815 N=1,4
  815 XL(L) = XL(L)+TDEL(N,L)*RNGLØD(N,J)
      DØ 816 L=1,4
  816 RNGLØD(L,J) = XL(L)
      IF (IWØRD.LE.2) GØ TØ 401
      RNLØD2(1,J) = 0.0
      RNLØD2(2,J) = 0.0
      RNLØD2(3,J) = -RØM*RC*A
      RNLØD2(4,J) = YBAR*RNLØD2(3,J)
  401 CØNTINUE
      DØ 1100 L=1,NSEG
      IF (JTNØ(J).EQ.JTIC(L)) GØ TØ 1105
 1100 CØNTINUE
      GØ TØ 1107
 1105 M = JTIC(L)
      RMULT = ADUS(M)*TWØPI
      GØ TØ 1111
 1107 DØ 1101 L=1,NSEG
      IF (JTNØ(J).EQ.JSTØP(L)) GØ TØ 1106
 1101 CØNTINUE
 1106 M = JSTØP(L)
      RMULT = BADUS(M)*TWØPI
 1111 CØNTINUE
      DØ 820 L=1,4
      DØ 820 M=1,4
  820 RNGTØT(L,M) = RNGTØT(L,M)*RMULT
      IF (Q.EQ.1) GØ TØ 402
      DØ 821 L=1,4
  821 RNGLØD(L,J) = RNGLØD(L,J)*RMULT
      IF (IWØRD.LE.2) GØ TØ 402
      DØ 405 L=1,4
  405 RNLØD2(L,J) = RNLØD2(L,J)*RMULT
  402 RETURN
      END
```

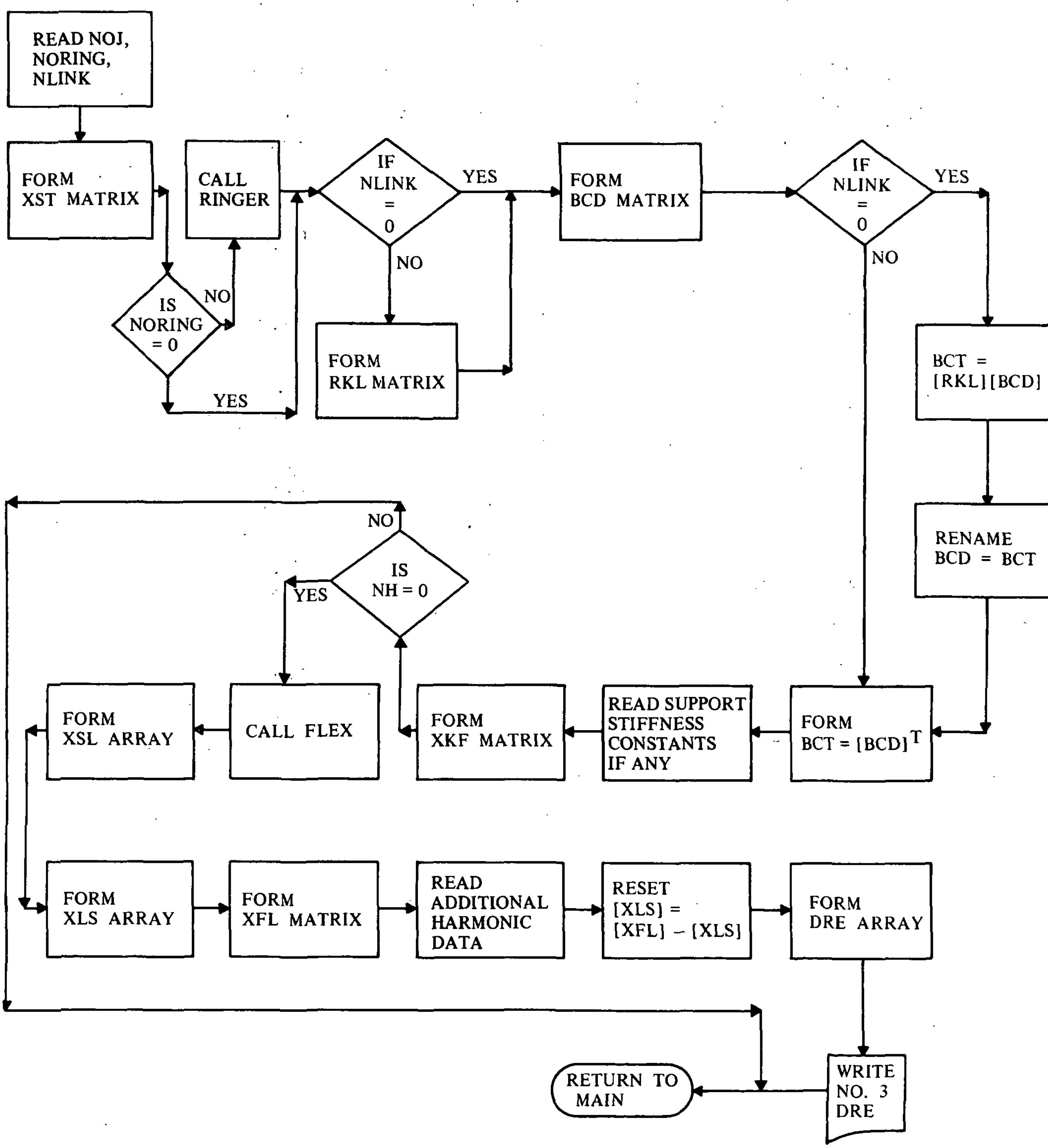
SUBROUTINE STRMAT

The region stiffness matrices, XKR, and the region load matrices, XLR, are passed from REGMAT to STRMAT via Tape #4 and Tape #8, and are placed in the XKSTOT array and the XLSTOT array, respectively. A matrix, BCD, is formed to represent the boundary conditions, and, if kinematic links occur between regions, the RKL matrix is developed to represent this situation. The subroutine RINGER is again called for discrete ring matrices. In passes other than the first pass, first cycle, the load calculations are not performed.

As a result of appropriate matrix operations, a reduced structure stiffness matrix is formed. In passes other than the first pass, first cycle, STRMAT terminates here. In the first pass, first cycle, the following calculations are made. Subroutine FLEX, a routine identical to SREVN2 (except for being in single precision) with the name changed due to the structure of the OVERLAY option, is called to invert the structure stiffness matrix thus producing A, the flexibility matrix for the structure. The region end deflection array, DRE, is produced as the result of another set of matrix operations.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
BCD MATRIX	$[BC]$
BCT MATRIX	$[BC]^T$
XST MATRIX	$[\hat{K}]_T$
XKF MATRIX	$[\hat{K}]_F$
A MATRIX	$[\hat{A}]_F$
XSL MATRIX	$[\hat{L}]_T$
XLS ARRAY	$\{\hat{L}\}_F$
XFL ARRAY	$\{\hat{F}\}_F$
DRE ARRAY	$\{\Delta\}_T$

STRMAT



READ NOJ, NORING, NLINK
FORM XST MATRIX
CALL RINGER
IS NORING = 0
NO
YES
IF NLINK = 0
YES
NO
FORM RKL MATRIX
FORM BCD MATRIX
IF NLINK = 0
YES
NO
BCT = [RKL] [BCD]
RENAME BCD = BCT
NO
IS NH = 0
YES
FORM XSL ARRAY
CALL FLEX
FORM XKF MATRIX
READ SUPPORT STIFFNESS CONSTANTS IF ANY
FORM BCT = [BCD]T
FORM XLS ARRAY
FORM XFL MATRIX
READ ADDITIONAL HARMONIC DATA
RESET [XLS] = [XFL] – [XLS]
FORM DRE ARRAY
RETURN TO MAIN
WRITE NO. 3 DRE

```
FØR,IS STRMAT,STRMAT
      SUBRØUTINE STRMAT (ICYC)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /ARING/ NRING(28),AMAT(30,4)
      CØMMØN /PLS/ ØMEGA,IWØRD
      DIMENSIØN SCLA(128),LØC(128)
      DIMENSIØN ICØL(10)
      DIMENSIØN RKL(120,120),ØPEN(4,4)
      DIMENSIØN DLP(4),BCD(124,124),TEMP(124),BCT(124),XKF(128),BC(128)
      DIMENSIØN A(124,124),XSL(124,2),XFL(124,2),DRE(128,2),BCA(128)
      DIMENSIØN XKR(8,8),XSTR(128),XLS(128,2),XLR(8,2)
      DIMENSIØN XST(124,124),XSTBC(124,124),TEMP1(124)
      DIMENSIØN RNGTØT(4,4),RNGLØD(4,28),JTNØ(28),RNLØD2(4,28)
      DIMENSIØN CØLTTL(2)
      EQUIVALENCE (XST(1),BCD(1),A(1),XSTBC(1),RKL(1),XLS(1))
      EQUIVALENCE (XSTR(1),XKF(1),XFL(1),XSL(1),DRE(1),SCLA(1),
     1             TEMP(1),ØPEN(1))
      EQUIVALENCE (XKR(1),XLR(1),BC(1),BCT(1),BCA(1),TEMP1(1),LØC(1))
      DATA CØLTTL/4H  CØ,4HLUMN/
      REWIND  2
      REWIND  3
      REWIND  4
      REWIND  8
      REWIND  9
      REWIND 14
      REWIND 15
    1 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))
  101 FØRMAT (3I5,16A4)
      WRITE(6,1726)
 1726 FØRMAT(1H1)
      IF (NPRØB.EQ.0.AND.NH.NE.0) GØ TØ 1700
      READ(5,101) NØJ,NØRING,NLINK
      NØJS = NØJ
      NLINKS = NLINK
      NRINGS = NØRING
      GØ TØ 1701
 1700 NØJ = NØJS
      NLINK = NLINKS
      NØRING = NRINGS
 1701 CØNTINUE
      NH4=4
      NH8=8
      NJTNH4=NØJ*NH4
      DØ 102  J=1,NJTNH4
      DØ 102  I=1,NJTNH4
  102 XST(I,J)=0.0
      DØ 100 NR=1,NREG
      READ(4) ((XKR(I,J),J=1,8),I=1,8)
      J1=JRTIC(NR)
      J2=JRSTØP(NR)
      II=4*(J1-1)
  450 JJ=4*(J2-1)+1
```

```
      II=II+1
      DØ 460 JK=1,4
      GØ TØ (451,452,453,454),JK
  451 IX=II
      IND=II
      DØ 461 I=1,4
      DØ 461 J=1,4
  461 ØPEN(I,J)=XKR(I,J)
      GØ TØ 455
  452 IX=II
      IND=JJ
      DØ 462 I=1,4
      DØ 462 J=1,4
  462 ØPEN(I,J)=XKR(I,J+4)
      GØ TØ 455
  453 IX=JJ
      IND=II
      DØ 463 I=1,4
      DØ 463 J=1,4
  463 ØPEN(I,J)=XKR(I+4,J)
      GØ TØ 455
  454 IX=JJ
      IND=JJ
      DØ 464 I=1,4
      DØ 464 J=1,4
  464 ØPEN(I,J)=XKR(I+4,J+4)
  455 DØ 456 I=1,4
      JX=IND
      DØ 457 J=1,4
      XST(IX,JX)=XST(IX,JX)+ØPEN(I,J)
  457 JX=JX+1
  456 IX=IX+1
  460 CØNTINUE
  100 CØNTINUE
      IF (NØRING.EQ.0) GØ TØ 1170
      MFLG = 2
      DØ 1211 J=1,NØRING
      CALL RINGER (Q,XN,RNGTØT,RNGLØD,J,SADUS,UADUS,JRTIC,JRSTØP,JTNØ,
     1             KBC,XNL,MFLG,NREG,RNLØD2)
      JT = 4*(JTNØ(J)-1)
      DØ 1220 I=1,4
      DØ 1220 IK=1,4
 1220 XST(JT+I,JT+IK) = XST(JT+I,JT+IK)+RNGTØT(I,IK)
 1211 CØNTINUE
      IF (Q.NE.5) GØ TØ 1170
      WRITE(6,300)
  300 FØRMAT(///)
      READ(5,2000)
 2000 FØRMAT(1X)
 1170 CØNTINUE
      DØ 107 I=1,NJTNH4
  107 WRITE (2) (XST(I,J),J=1,NJTNH4)
      REWIND 2
      REWIND 4
      IF (NH.NE.0) GØ TØ 3108
C   GENERATIØN ØF BC BØUNDARY CØNDITIØN SCRAMBLING MATRIX
      WRITE(6,347) NØJ,NLINK
  347 FØRMAT(////51X30HINPUT DATA FØR REGIØN CØUPLING///31X24HNUMBER ØF
     1REGIØN JØINTS ,I3,14X26HNUMBER ØF KINEMATIC LINKS ,I3///44X6HREGIØ
     2N11X8HJØINT(I)11X8HJØINT(J)//)
      DØ 348 I=1,NREG
```

```
      KTIC=JRTIC(I)
      KSTØP=JRSTØP(I)
      WRITE(6,349) I,KTIC,KSTØP
  349 FØRMAT(46X,I2,2(16X,I3))
  348 CØNTINUE
      IF(NLINK.EQ.0) GØ TØ 3108
      DØ 756 I=1,NJTNH4
       DØ 756 J=1,NJTNH4
  756 RKL(I,J)=0.0
      DØ 757 I = 1,NJTNH4
  757 RKL(I,I) = 1.0
      DØ 789 I=1,4
       DØ 789 J=1,4
  789 ØPEN(I,J)=0.0
      ØPEN(2,2) = 1.0
      ØPEN(3,3) = 1.0
      ØPEN(4,4) = 1.0
      WRITE(6,1824)
 1824 FØRMAT(//60X,12HREGIØN LINKS//43X,8HJØINT(J),5X,8HJØINT(I),
     15X,20HANGLE ØF ØRIENTATIØN)
      DØ 502 NRIG=1,NLINK
      READ(5,503) JD,JI,CØTAN
  503 FØRMAT(2I2,E14.7)
      WRITE(6,1828) JD,JI,CØTAN
 1828 FØRMAT(46X,I2,11X,I2,11X,E14.7)
      CØTAN = CØS(CØTAN)/SIN(CØTAN)
      ØPEN(1,1) = SADUS(JD) / SADUS(JI)
      ØPEN(2,4) = - (SADUS(JD)-SADUS(JI))
      ØPEN(3,4) = - ØPEN(2,4)* CØTAN
      IXX= JD*4-3
      DØ 504 I=1,4
      JXX= JI*4-3
      DØ 505 J=1,4
      RKL(IXX,JXX)=ØPEN(I,J)
  505 JXX=JXX+1
  504 IXX=IXX+1
  502 CØNTINUE
      READ(5,2000)
      NTRKL = 15
      DØ 781 I=1,NJTNH4
  781 WRITE(15) (RKL(I,J),J=1,NJTNH4)
      REWIND 15
 3108 CØNTINUE
      IF (LINPUT.EQ.0) GØ TØ 3200
      DØ 108 J=1,NJTNH4
      DØ 108 I=1,NJTNH4
  108 BCD(I,J)=0.0
      ICR =1
      WRITE(6,2372)
 2372 FØRMAT(//////57X19HBØUNDARY CØNDITIØNS//30X5HJØINT5X7HDELTA T,5X,7
     1HDELTA Z,5X,7HDELTA R,5X,7H THETA ,7X,11HANGLE ALPHA)
      DØ 109 J=1,NØJ
      READ (5,110) JN,DLP(1),DLP(2),DLP(3),DLP(4),ANGLE
  110 FØRMAT  (I2,4F2.0,E14.1)
      I1 = DLP(1)
      I2 = DLP(2)
      I3 = DLP(3)
      I4 = DLP(4)
      WRITE(6,2373) JN,I1,I2,I3,I4,ANGLE
 2373 FØRMAT(/31X,I3,9X,I2,10X,I2,10X,I2,10X,I2, 7X,E14.7)
      II  = (4*JN)-3
```

```
      DØ 121 I=1,4
      IF(DLP(I)-1.0) 113,114,115
  115 IF(DLP(I)-2.0) 116,116,117
  114 BCD(II,ICR)=1.0
      GØTØ 118
  116 BCD(II,ICR)=SIN(ANGLE)
      BCD(II+1,ICR)= -CØS(ANGLE)
      GØTØ 118
  117 BCD(II-1,ICR)=CØS(ANGLE)
      BCD(II,ICR)=SIN(ANGLE)
  118 ICR=ICR+1
  113 II=II+1
  121 CØNTINUE
  109 CØNTINUE
      READ(5,2000)
      ICR=ICR-1
      NZ=ICR
      IF(NLINK.EQ.0) GØ TØ 3124
      DØ 783 N=1,NJTNH4
      READ(NTRKL) (TEMP(M),M=1,NJTNH4)
      DØ 782 J=1,NZ
      BCT(J)=0.0
      DØ 782 I=1,NJTNH4
  782 BCT(J)=BCT(J)+TEMP(I)*BCD(I,J)
  783 WRITE (4)  (BCT(L),L=1, NZ)
      REWIND NTRKL
      REWIND 4
      DØ 126 M=1,NJTNH4
  126 READ(4) (BCD(M,N),N=1,NZ)
C     AT THIS PØINT THE BCD ARRAY IS THE PRØDUCT ØF RKL AND BCD ARRAYS
 3124 CØNTINUE
      NBCT = 3
      DØ 124 J=1,NZ
  124 WRITE (3)  (BCD(I,J),I=1,NJTNH4)
      DØ 125 I=1,NJTNH4
  125 WRITE (3)  (BCD(I,J),J=1,NZ)
      REWIND 3
      WRITE(14) ((BCD(I,J),J=1,NZ),I=1,NJTNH4)
      DØ 3300 J=1,NZ
 3300 WRITE(14) (BCD(I,J),I=1,NJTNH4)
      REWIND 4
      GØ TØ 3201
 3200 READ(14) ((BCD(I,J),J=1,NZ),I=1,NJTNH4)
 3201 CØNTINUE
      DØ 180  L=1,NJTNH4
      READ (2) (XSTR(J),J=1,NJTNH4)
      DØ 184  M=1,NZ
      TEMP1(M) = 0.0
      DØ 181  N=1,NJTNH4
  181 TEMP1(M) = TEMP1(M)+XSTR(N)*BCD(N,M)
  184 CØNTINUE
      WRITE(4) (TEMP1(I),I=1,NZ)
  180 CØNTINUE
      REWIND 4
      DØ 183  II=1,NJTNH4
  183 READ (4) (XSTBC(II,JJ),JJ=1,NZ)
      REWIND 4
      DØ 182  N=1,NZ
      READ(NBCT) (BCT(J),J=1,NJTNH4)
      DØ 185  M=1,NZ
      XKF(M)=0.0
```

```
      DØ 186  K=1,NJTNH4
  186 XKF(M)=XKF(M)+BCT(K)*XSTBC(K,M)
  185 CØNTINUE
      WRITE (4) (XKF(I),I=1,NZ)
      IF (NPASS.GT.2) GØ TØ 182
      IF (NPASS.EQ.2.AND.(IWØRD.EQ.1.ØR.(XN1.EQ.0.AND.(IWØRD.EQ.3.ØR.
     1    IWØRD.EQ.5)))) GØ TØ 182
      IF (ICYC.NE.1.AND.NPASS.EQ.2) GØ TØ 182
      WRITE(11) (XKF(I),I=1,NZ)
  182 CØNTINUE
      NBCT = 14
      REWIND 2
      REWIND 4
      REWIND 11
      DØ 187 I=1,NZ
  187 READ(4) (A(I,J),J=1,NZ)
      IF (IBEGIN.EQ.0) GØ TØ 1750
      WRITE(6,1726)
      WRITE(6,2365)
 2365 FØRMAT(50X,29H THE REDUCED STIFFNESS MATRIX/)
      NUMBER = 2
      JJ = 0
      JJJ = 0
 1725 JJ = JJJ + 1
      JJJ = JJJ + 8
      MM = 8
      IF (JJJ.GT.NZ) MM=8-(JJJ-NZ)
      MMM = JJ
      IF(JJJ.GT.NZ) JJJ=NZ
      DØ 1721 M=1,MM
      ICØL(M)=MMM
 1721 MMM = MMM + 1
      NUMBER = NUMBER + 3
      WRITE(6,1729) ((CØLTTL,ICØL(M)),M=1,MM)
 1729 FØRMAT(/10H   RØW     ,8(2A4,1X,I3,3X)/)
      DØ 1722 I=1,NZ
      NUMBER = NUMBER + 1
      WRITE(6,1728)I,(A(I,J),J=JJ,JJJ)
 1728 FØRMAT(3X,I3,4X,8(E14.7,1X))
      IF(NUMBER.LT.55) GØ TØ 1722
      NUMBER = 3
      WRITE(6,1726)
      WRITE(6,1729) ((CØLTTL,ICØL(M)),M=1,MM)
 1722 CØNTINUE
      IF(JJJ.NE.NZ) GØ TØ 1725
 1750 CØNTINUE
      IF (NH.NE.0.ØR.NLCASE.EQ.0) GØ TØ 7
      DDC = 0.0
      RØR = 0.0
      CALL FLEX (A,NZ,SCLA,124,NIX)
      IF (NIX.NE.0) GØ TØ 8777
      DØ 804 L=1,NJTNH4
      READ(3) (BC(I),I=1,NZ)
      DØ 716 M=1,NZ
      TEMP(M) = 0.0
      DØ 805 N=1,NZ
  805 TEMP(M) = TEMP(M) + BC(N)*A(N,M)
  716 CØNTINUE
      WRITE (2) (TEMP(I),I=1,NZ)
  804 CØNTINUE
      REWIND 2
```

```
      REWIND 3
      DØ 991 J=1,NPRØB
      DØ 991 I=1,NJTNH4
  991 XSL(I,J) = 0.0
 1001 DØ 777 NR=1,NREG
      J1 = JRTIC(NR)
      J2 = JRSTØP(NR)
      READ(8) ((XLR(I,J),J=1,NPRØB),I=1,NH8)
      DØ 777 N2 = 1,2
      GØTØ (11,12),N2
   11 II = (J1-1)*NH4+1
      III= II+NH4-1
      GØTØ 3
   12 II = (J2-1)*4+1
      III= II+NH4-1
    3 DØ 777 J=1,NPRØB
      I=0
      IF(N2.EQ.2) I=NH4
      DØ 777 IL=II,III
      I=I+1
  777 XSL(IL,J) = XSL(IL,J)+XLR(I,J)
      IF (NØRING.EQ.0) GØ TØ 1150
      DØ 1225 J=1,NØRING
      JT = 4*(JTNØ(J)-1)
      DØ 1227 I=1,4
      DØ 1226 IK=1,NPRØB
 1226 XSL(JT+I,IK) = XSL(JT+I,IK)+RNGLØD(I,J)
      IF (IWØRD.GE.3) XSL(JT+I,NPRØB) = XSL(JT+I,NPRØB)+RNLØD2(I,J)
 1227 CØNTINUE
 1225 CØNTINUE
 1150 CØNTINUE
      DØ 876 N=1,NZ
      READ(3) (BCT(J),J=1,NJTNH4)
      DØ 717 M=1,NPRØB
      XLS(N,M) = 0.0
      DØ 806 K=1,NJTNH4
  806 XLS(N,M) = XLS(N,M) + BCT(K)*XSL(K,M)
  717 CØNTINUE
  876 CØNTINUE
      REWIND 3
      DØ 301 J=1,NPRØB
      DØ 301 I=1,NZ
  301 XFL(I,J) = 0.0
      IF (IWØRD.EQ.3.ØR.IWØRD.EQ.5) GØ TØ 306
      READ(5,302)  LINLØD,(STØRY(I),I=1,16)
  302 FØRMAT(I4,16A4)
      IF(LINLØD.EQ.0)  GØ TØ 303
      WRITE(6,341)
  341 FØRMAT(1H1///57X,19HEXTERNAL LINE LØADS///36X,14HPRØBLEM NUMBER,7X
     120HPØINT ØF APPLICATIØN,7X,12HAPPLIED LØAD//)
      DØ 304 N=1,LINLØD
      READ(5,305) JEXT2,JEXT1,XFL(JEXT1,JEXT2)
  305 FØRMAT(2I5,E14.7)
      WRITE(6,342) JEXT2,JEXT1,XFL(JEXT1,JEXT2)
  342 FØRMAT(41X,I3,22X,I3,15X,E14.7)
  304 CØNTINUE
  303 CØNTINUE
      READ(5,2000)
  306 CØNTINUE
      DØ 811 J=1,NPRØB
      DØ 811 I=1,NZ
```

```
 811 XLS(I,J)=XFL(I,1)-XLS(I,J)                                          1503610
     REWIND 3                                                            1503620
     DØ 812 J=1,NJTNH4                                                   1503630
     READ (2) (BCA(K),K=1,NZ)                                            1503640
     DØ 813 M=1,NPRØB                                                    1503650
     DRE(J,M)=0.0                                                        1503660
     DØ 813 N=1,NZ                                                       1503670
 813 DRE(J,M)=DRE(J,M)+BCA(N)*XLS(N,M)                                   1503680
 812 CØNTINUE                                                            1503690
     WRITE(6,1726)                                                       1503700
     WRITE(6,2368)                                                       1503710
2368 FØRMAT(31X,70HTHE EXPANDED REGIØN JØINT DISPLACEMENT MATRIX (REGIØ 1503720
    1N END DEFLECTIØNS))                                                 1503730
     WRITE(6,1770)                                                       1503740
1770 FØRMAT(//14X,5HJØINT,14X,7HPRØBLEM,13X,7HDELTA T,13X,7HDELTA Z,13X 1503750
    1,7HDELTA R,11X,11HØMEGA-THETA)                                      1503760
     NUMBER = 4                                                          1503770
     KK=-3                                                               1503780
     DØ 1735 J=1,NØJ                                                     1503790
     NUMBER = NUMBER + NPRØB + 1                                         1503800
     IF(NUMBER.LT.56) GØ TØ 1745                                         1503810
     WRITE(6,1726)                                                       1503820
     WRITE(6,1770)                                                       1503830
     NUMBER=2+NPRØB+3                                                    1503840
1745 KK=KK+4                                                             1503850
     KKK=KK+3                                                            1503860
     WRITE(6,1739)                                                       1503870
1739 FØRMAT(1H )                                                         1503880
     DØ 1764 L=1,NPRØB                                                   1503890
     WRITE(6,1765) J,L,(DRE(K,L),K=KK,KKK)                               1503900
1765 FØRMAT(15X,I2,18X,I2,9X,4(3X,E14.7,3X))                             1503910
1764 CØNTINUE                                                            1503920
1735 CØNTINUE                                                            1503930
     DØ 71  NR=1,NREG                                                    1503940
     DØ 71  K=1,2                                                        1503950
     II =(JRTIC(NR) - 1) *4 +1                                           1503960
     IF(K.EQ.2) II= JRSTØP(NR)*4-3                                       1503970
     III= II + 3                                                         1503980
     DØ 71 I = II,III                                                    1503990
  71 WRITE(3) (DRE(I,J),J=1,NPRØB)                                       1504000
     REWIND 2                                                            1504010
     REWIND 3                                                            1504020
     REWIND 4                                                            1504030
     GØTØ 7                                                              1504040
8777 IERRØR =8777                                                        1504050
     NERRØR=32                                                           1504060
     NIX=1                                                               1504070
   7 CØNTINUE
     RETURN                                                              1504120
      END                                                                1504130
```

```
FØR,IS FLEX,FLEX
      SUBRØUTINE FLEX (A,M,LØC,MID,NIX)
C
C   MATRIX INVERSIØN
C
C  A-CØNVENTIØNAL FØRTRAN DØUBLE ARRAY CØNTAINING MATRIX TØ BE INVERTED
C  M- MATRIX ØRDER
C  LØC-  SINGLE ARRAY DIMENSIØNED AT LEAST TØ M
C  MID-  FIRST DIMENSIØN ØF A,NØT LESS THAN M
C  NIX-  ERRØR INDICATØR, SET TØ ZERØ AFTER SUCCESSFUL EXECUTIØN.
C
      DIMENSIØN A(MID,1)
      INTEGER LØC(1)
  100 N = M
      DØ 190  K = 1,N
      PIVØT = C.0
      DØ 120  I = K,N
      IF (PIVØT -  ABS(A(I,K))) 110,110,120
  110 PIVØT =  ABS(A(I,K))
      L = I
  120 CØNTINUE
      IF (PIVØT) 140,130,140
  130 NIX = -1
      GØ TØ 210
  140 LØC(K) = L
      DØ 150  J = 1,N
      TEMP1 = A(K,J)
      A(K,J) = A(L,J)
  150 A(L,J) = TEMP1
      TEMP1=A(K,K)
      A(K,K) = 1.0
      DØ 160  J = 1,N
  160 A(K,J) = A(K,J)/TEMP1
      DØ 190  I = 1,N
      IF (I - K) 170,190,170
  170 TEMP1 = -A(I,K)
      A(I,K) = 0.0
      DØ 180   J = 1,N
  180 A(I,J) = A(I,J) + TEMP1*A(K,J)
  190 CØNTINUE
      DØ 200  K = 1,N
      NK = N - K
      L = LØC(NK+1)
      DØ 200  I = 1,N
      TEMP1 = A(I,NK+1)
      A(I,NK+1) = A(I,L)
  200 A(I,L) = TEMP1
      NIX = 0
  210 RETURN
      END
```

SUBROUTINE INITAL

As a result of the matrix operations performed in REGMAT, the SKL22, the XK2221, and the XK22L2 arrays for each region are passed to INITAL. The XK1112 and XL1 arrays for each segment, resulting from the matrix procedures in SEGMAT, are also passed to INITAL. The region end deflection matrices, DRE, which were formed in STRMAT or BCVECT are transmitted to INITAL.

Following appropriate matrix operations upon these arrays, the force initial conditions, the FICS array, and the deflections initial conditions, the DICS array, are produced. These arrays combine to form the YICS matrix, which contains the true initial conditions for the structure to be analyzed.

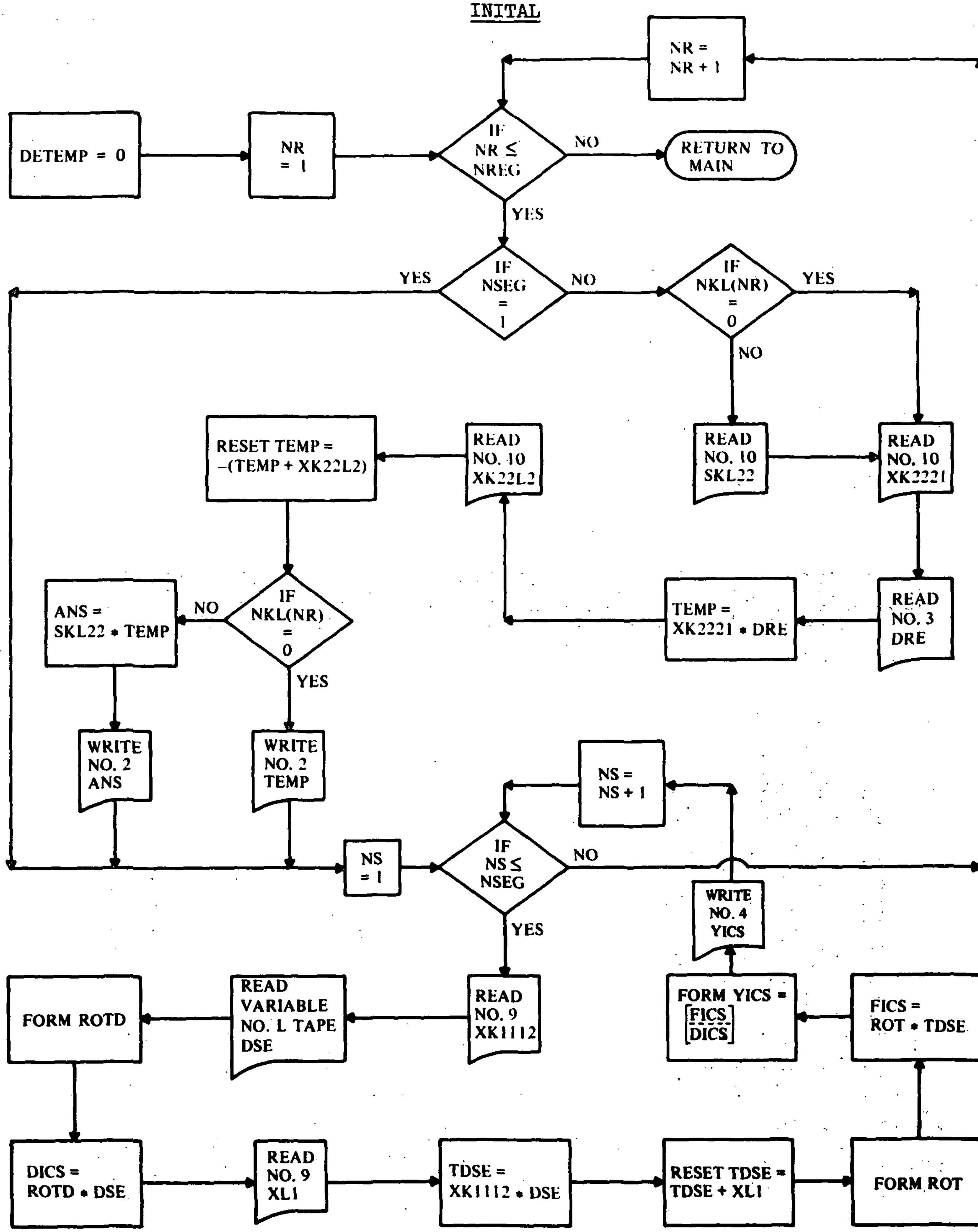
The pertinent counters in the subroutine are:

NS = segment counter

NR = region counter

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
XK2221 MATRIX	$\left[\hat{K}_{22}\right]^{-1} \left[\hat{K}_{21}\right]$
XK22L2 MATRIX	$\left[\hat{K}_{22}\right]^{-1} \left[\hat{L}\right]$
DSE ARRAY	$\left\{\Delta\right\}$
XK1112 MATRIX	$\left[k_{ii} \mid k_{ij}\right]$
ROTD MATRIX	$\left[IDT\right]^{T}$
DICS ARRAY	$\left\{\delta(i)\right\}$
XL1 ARRAY	$\left\{\ell(i)\right\}$
ROT MATRIX	$\left[IFT\right]^{T}$
FICS ARRAY	$\left\{f(i)\right\}$

INITAL


NR = NR + 1
DETEMP = 0
NR = 1
IF NR ≤ NREG
NO
YES
RETURN TO MAIN
IF NSEG = 1
YES
NO
IF NKL(NR) = 0
YES
NO
RESET TEMP = −(TEMP + XK22L2)
READ NO. 10 XK22L2
READ NO. 10 SKL22
READ NO. 10 XK2221
ANS = SKL22 * TEMP
NO
IF NKL(NR) = 0
YES
TEMP = XK2221 * DRE
READ NO. 3 DRE
WRITE NO. 2 ANS
WRITE NO. 2 TEMP
NS = NS + 1
NS = 1
IF NS ≤ NSEG
NO
YES
WRITE NO. 4 YICS
FORM ROTD
READ VARIABLE NO. L TAPE DSE
READ NO. 9 XK1112
FORM YICS = [FICS DICS]
FICS = ROT * TDSE
DICS = ROTD * DSE
READ NO. 9 XL1
TDSE = XK1112 * DSE
RESET TDSE = TDSE + XL1
FORM ROT

```
FØR,IS INITAL,INITAL
      SUBRØUTINE INITAL
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      CØMMØN STØRY(16),XMAT(11C,10),STD(10),SADUS(3C),RADUS(30)
      CØMMØN TADUS(30),UADUS(3C),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      DIMENSIØN XK2221(112,8),DRE(8,2),TEMP(112,2),XK22L2(112,2)
      DIMENSIØN XK1112(4,8),DSE(8,2),RØTD(4,4),DICS(4,2)
      DIMENSIØN TDSE(8,2),YICS(8,2)
      DIMENSIØN XL1(4,2),RØT(4,4),FICS(4,2),SKL22(112,112),ANS(112,2)
      EQUIVALENCE (RØT(1),RØTD(1)),(TIC,TICK)
      EQUIVALENCE (DSE(1),DRE(1)),(XK2221(1),XK22L2(1))
      EQUIVALENCE (SKL22(1),XK1112(1)),(YICS(1),TDSE(1))
      NH4 = 4
      NH41=NH4+1
      NH8 = 8
      NH81=NH8+1
      REWIND  2
      REWIND  3
      REWIND  4
       REWIND  8
      REWIND  9
      REWIND 1C
    1 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))
      DØ 100 NR=1,NREG
      NØJ = NST(NR) + NKL(NR) + 1
      ISKL22 = 4*(NØJ-2)
      JSKL22 = 4*(NØJ-2-NKL(NR))
      NJTNH4=NØJ*NH4
      M8=4*(NØJ-NKL(NR))-8
      NSEG=NST(NR)
      IF (NSEG.EQ.1) GØTØ 703
      IF(NKL(NR).EQ.0) GØ TØ 415
      DØ 425 I=1,ISKL22
  425 READ (10) (SKL22(I,J),J=1,JSKL22)
  415 READ(10)  ((XK2221(I,J),J=1,NH8),I=1,M8)
      READ(10) (SAVJTC(I),SAVSTP(I),I=1,NSEG)
  703 DØ 91 K = 1,2
      II = 1
      IF(K.EQ.2) II=5
      III = II+3
      DØ 91 I=II,III
   91 READ(3) (DRE(I,J),J=1,NPRØB)
      IF (NSEG.EQ.1) GØTØ 999
      DØ 101 J=1,NPRØB
      DØ 101 I=1,M8
      TEMP(I,J)=0.0
      DØ 101 K=1,NH8
      TEMP(I,J)=TEMP(I,J)+XK2221(I,K)*DRE(K,J)
  101 CØNTINUE
      IF (NH.NE.0) GØ TØ 510
      READ(10)((XK22L2(I,J),J=1,NPRØB),I=1,M8)
      GØ TØ 511
  510 DØ 512 I=1,M8
      DØ 512 J=1,NPRØB
```

```
512 XK22L2(I,J) = 0.0
511 CØNTINUE
    DØ 102 J=1,NPRØB
    DØ 102 I=1,M8
102 TEMP(I,J)= -(TEMP(I,J)+XK22L2(I,J))
    IF(NKL(NR).EQ.0) GØ TØ 435
    DØ 445 I = 1,ISKL22
    DØ 445 J=1,NPRØB
    ANS(I,J)=C.0
    DØ 445 K = 1,JSKL22
445 ANS(I,J)=ANS(I,J)+SKL22(I,K)*TEMP(K,J)
435 DØ 391 N=1,NSEG
    IF((N.EQ.1.ØR.N.EQ.NSEG).AND.SAVJTC(N).GT.SAVSTP(N)) GØ TØ 370
    DØ 398 K=1,2
    IF (N.NE.1.ØR.K.NE.1) GØTØ 393
    DØ 394 I= 1,4
394 WRITE (2) (DRE(I,J),J=1,NPRØB)
    GØ TØ 398
393 IF(N.EQ.NSEG.AND.K.EQ.2) GØTØ 395
    IF (K.EQ.1) II = SAVJTC(N)*4-7
    IF (K.EQ.2) II = SAVSTP(N)*4-7
    III = II + 3
    DØ 397 I=II,III
    IF (NKL(NR).EQ.0) GØTØ 392
    WRITE (2) (ANS(I,J),J=1,NPRØB)
    GØTØ 397
392 WRITE (2) (TEMP(I,J),J=1,NPRØB)
397 CØNTINUE
    GØ TØ 398
395 DØ 396 I=5,8
396 WRITE (2) (DRE(I,J),J=1,NPRØB)
398 CØNTINUE
    GØ TØ 391
370 IF(N.EQ.NSEG) GØ TØ 380
    IF(NKL(NR).EQ.0) GØ TØ 375
    DØ 371 I=1,4
371 WRITE(2) (ANS(I,J),J=1,NPRØB)
    GØ TØ 376
375 DØ 372 I=1,4
372 WRITE(2) (TEMP(I,J),J=1,NPRØB)
376 DØ 373 I=1,4
373 WRITE(2) (DRE(I,J),J=1,NPRØB)
     GØ TØ 391
380 II =M8 - 3
     III = M8
     DØ 381 I=5,8
381 WRITE(2) (DRE(I,J),J=1,NPRØB)
     IF(NKL(NR).EQ.0) GØ TØ 385
     DØ 382 I=II,III
382 WRITE(2) (ANS(I,J),J=1,NPRØB)
     GØ TØ 391
385 DØ 383 I=II,III
383 WRITE(2) (TEMP(I,J),J=1,NPRØB)
391 CØNTINUE
    REWIND 2
999 DØ 201 NS=1,NSEG
    READ  (9) ((XK1112(I,J),J=1,NH8),I=1,NH4),IGEØM,G1
    ISEG=0
    NR1=NR-1
    IF(NR1.EQ.0)GØTØ8
    DØ 7 I=1,NR1
```

```
    7 ISEG=ISEG+NST(I)
    8 ISEG=ISEG+NS
      TIC= SAVTIC(ISEG)
      GØ TØ (21,22,23),IGEØM
   21 SN = DSIN(TIC)
      CS = DCØS(TIC)
      GØ TØ 25
   22 SN = CØS(1.570796-G1)
      CS = SIN(1.570796-G1)
      GØ TØ 25
   23 SN = 1.0
      CS = 0.0
   25 CØNTINUE
      IF (NSEG.EQ.I) GØ TØ 80
      DØ 78 I = 1,8
   78 READ (2) (DSE(I,J),J=1,NPRØB)
   80 CØNTINUE
      DØ 302 J=1,NH4
      DØ 302 I=1,NH4
  302 RØTD(I,J)=0.0
      DØ 305 J=1,NH4,4
      RØTD(J,J)=1.C
      RØTD(J+1,J+2)=CS
      RØTD(J+2,J+1)=-CS
      RØTD(J+1,J+1)=-SN
      RØTD(J+2,J+2)=-SN
  305 RØTD(J+3,J+3)=1.C
      DØ 306 J=1,NPRØB
      DØ 306 I=1,NH4
      DICS(I,J)=0.C
      DØ 306 K=1,NH4
  306 DICS(I,J)=DICS(I,J)+RØTD(I,K)*DSE(K,J)
      DØ 350 J=1,NPRØB
      DØ 350 I=1,NH4
  350 XL1(I,J) = 0.0
      IF (NH.EQ.0) READ(9) ((XL1(I,J),J=1,NPRØB),I=1,NH4)
      DØ 202 J=1,NPRØB
      DØ 202 I=1,NH4
      TDSE(I,J)=0.0
      DØ 202 K=1,NH8
  202 TDSE(I,J)=TDSE(I,J)+XK1112(I,K)*DSE(K,J)
      DØ 203 J=1,NPRØB
      DØ 203 I=1,NH4
  203 TDSE(I,J)=TDSE(I,J)+XL1(I,J)
      DØ 301 J=1,NH4
      DØ 301 I=1,NH4
  301 RØTD(I,J)=0.0
      DØ 204 J=1,NH4,4
      RØT(J,J)=-1.0
      RØT(J+1,J+2)=-CS
      RØT(J+2,J+1)= CS
      RØT(J+1,J+1)=SN
      RØT(J+2,J+2)=SN
  204 RØT(J+3,J+3)=1.0
      DØ 205 J=1,NPRØB
      DØ 205 I=1,NH4
      FICS(I,J)=0.0
      DØ 205 K=1,NH4
  205 FICS(I,J)=RØT(I,K)*TDSE(K,J)+FICS(I,J)
      DØ 402 J=1,NPRØB
      DØ 402 I=1,NH4
```

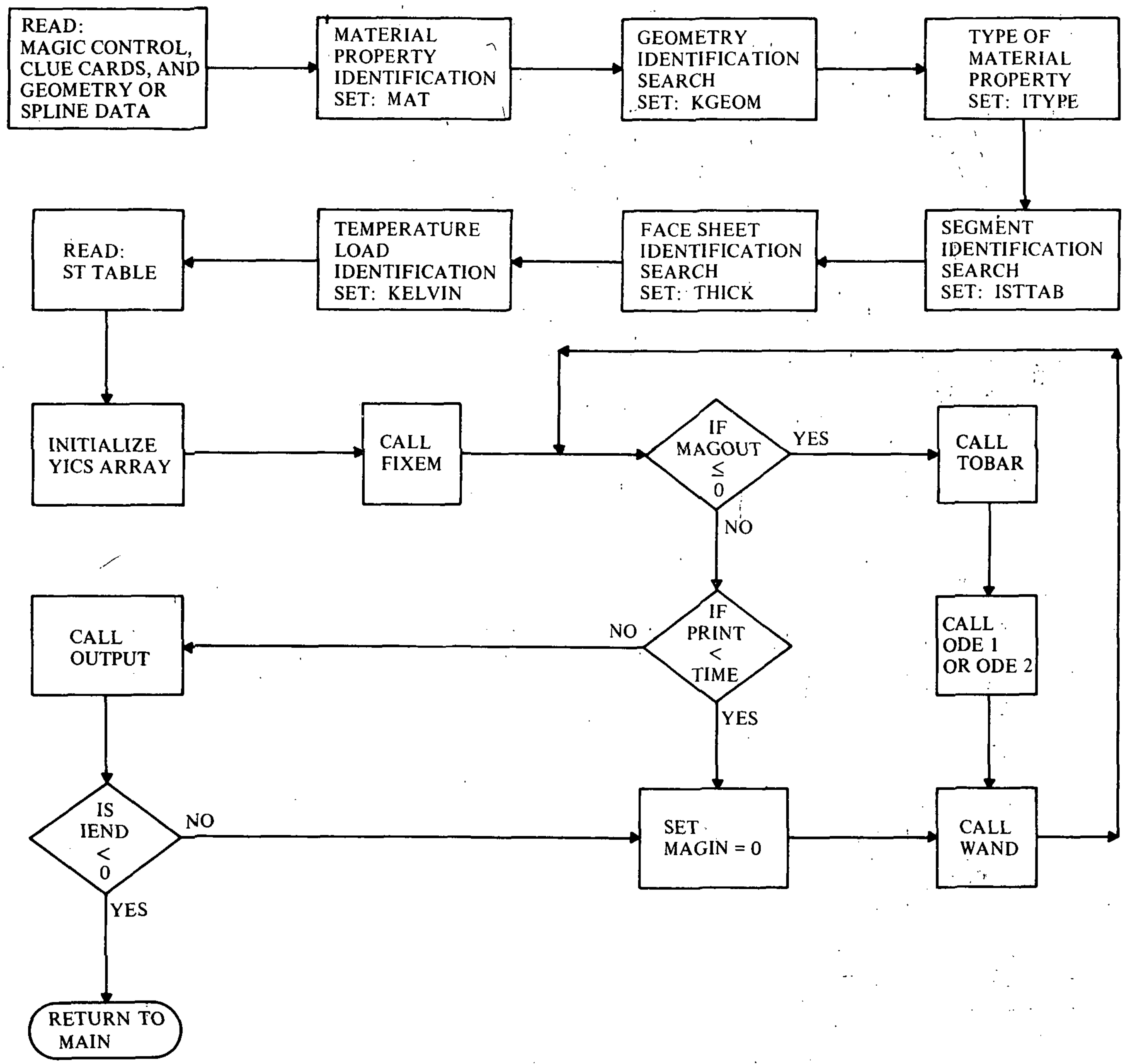
```
      II=I+NH4
      YICS(I,J)=FICS(I,J)
  402 YICS(II,J)=DICS(I,J)
      WRITE(4)    ((YICS(I,J),I=1,8),J=1,NPRØB)
  201 CØNTINUE
      REWIND 2
  100 CØNTINUE
      REWIND  1
      REWIND  4
       REWIND  8
      RETURN
       END
```

SUBROUTINE LEBEGE

The subroutine link LEBEGE receives the YICS array for each segment from INITAL via Tape #4. The subroutine FIXEM is called to integrate the differential equations of each segment, under true load conditions. FIXEM is identical to subroutine SETUP, while WAND corresponds to subroutine MAGIC and only consideration of the OVERLAY structure dictates the change in names. The subroutines TOBAR, TEMOEG, PLYCO, and PLYNE are similarly equivalent to ROBOT, GEOMET, PLICO, and PLINE discussed previously.

The results of the final integration sequence are the forces and deflections at the beginning, intermediate, and end points of each segment. In the first pass, first cycle, the prestress and predeformation states are printed from this routine. In other passes the U, V, W eigenvectors are printed, providing convergence has been reached.

LEBEGE



READ: MAGIC CONTROL, CLUE CARDS, AND GEOMETRY OR SPLINE DATA
MATERIAL PROPERTY IDENTIFICATION SET: MAT
GEOMETRY IDENTIFICATION SEARCH SET: KGEOM
TYPE OF MATERIAL PROPERTY SET: ITYPE
SEGMENT IDENTIFICATION SEARCH SET: ISTTAB
FACE SHEET IDENTIFICATION SEARCH SET: THICK
TEMPERATURE LOAD IDENTIFICATION SET: KELVIN
READ: ST TABLE
INITIALIZE YICS ARRAY
CALL FIXEM
IF MAGOUT ≤ 0
YES
NO
CALL TOBAR
CALL ODE 1 OR ODE 2
IF PRINT < TIME
NO
YES
CALL OUTPUT
IS IEND < 0
NO
YES
SET MAGIN = 0
CALL WAND
RETURN TO MAIN

```
FØR,IS LEBEGE,LEBEGE
      SUBRØUTINE LEBEGE
      INTEGER SAVJTC,SAVSTP,SEGTAB, Q ,THICK,TYPE
      INTEGER XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN DTAU,DIFF,STEP,DELTA,TIME,DTIME
      DØUBLE  PRECISIØN  YNEW,YPRED
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,C,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /NAM1/ FACE(4),STRGØ(7),THERM(4),MATER(3),SEGTAB(12)
      CØMMØN /ARING/ NRING(28)
      CØMMØN /SNILPS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1       DR1DP(100),ZI(14),RI(14),NRZIN
      CØMMØN /MAGIQ/ KKNT
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),
     1              YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,
     2              S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3              X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4              X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,
     6              XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7 XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),
     8              XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9              XK11,XK12,XK21,XK22,XK33,XD11,
     A                 M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,
     B            ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH
     C              ,XNPHI,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      DIMENSIØN TMPAV(5),RWØ(8)
      DIMENSIØN LST(13),YCEV(16),YICS(16),YNEW(16)
      DIMENSIØN XKF(128),TBDEL(16),FWDEL(16),YCØRR(16)
      DIMENSIØN ST(72,31), XLAYER(10)
      DIMENSIØN XSAVY(3,2)
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),
     1            (XNTPH,XNTEPH)
      EQUIVALENCE  (XNPHI,XNPI)
      EQUIVALENCE (YNEW(1),XKF(1))
      EQUIVALENCE (XSAVY(1,1),SAVY(1))
      REWIND  1
  600 FØRMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))
      KSC = 0
      JAM =1
      JNSC =0
      DØ 451 I=1,NREG
  451 KSC = KSC + NST(I)
      LSC = 0
  902 LSC = LSC + 1
      XNTTH = 0.0
      XNTPH = 0.0
      XMTTH = 0.0
      XMTPH = 0.0
      NSC=LSC
      JNSC=JNSC+1
      IF(JNSC.LE.NST(JAM)) GØ TØ 1727
      NRNG = NRING(JAM)
      IF (NRNG.EQ.0) GØ TØ 1900
```

```
      DØ 1901 I=1,NRNG
 1901 READ(1) DUMLNK
 1900 CØNTINUE
      NNSKL = NKL(JAM)
      IF (NNSKL.EQ.0) GØ TØ 1724
      DØ 1725 I=1,NNSKL
 1725 READ(1) DUMLNK
 1724 CØNTINUE
      JAM=JAM+1
      JNSC=I
 1727 CØNTINUE
      READ(1) RGØ,ANG,STØRY
      READ(1) DTAU,DIFF,STEP,DELTA
      IF (RGØ.EQ.14.0) GØ TØ 182
      READ(1)       G1,G2,G3
      CØ TØ 183
  182 READ(1) NRZIN,(ZI(J),RI(J),J=1,NRZIN)
  183 CØNTINUE
      READ(1) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,NP
      DIFF  =1.0E-04
      EPSIL =1.0E-05
      ERR = 1.0 E-07
      I = RGØ
      WRITE(6,1726)
 1726 FØRMAT(1H1)
      IF(JNSC.EQ.1) WRITE(6,606) JAM,NST(JAM),NKL(JAM)
  606 FØRMAT(//58X,13HREGIØN NUMBER,I3//35X,10HTHERE ARE ,I2,14H SEGMENT
     1S AND ,I2,35H KINEMATIC LINKS WITHIN THIS REGIØN)
      WRITE(6,651)  JNSC,I  ,(STØRY(I),I=1,16)
  651 FØRMAT(//13X,15HSEGMENT NUMBER ,I2,5X,13HSEGMENT CØDE ,I2,5X,
     116A4)
C     MATERIAL PRØPERTY IDENTIFICATIØN
      DØ 501 I=1,NMPT
      IF (HLAYR-STD(I)) 501,502,501
  502 MAT=I
      GØTØ 503
  501 CØNTINUE
      GØTØ 8036
  503 CØNTINUE
C     GEØMETRY IDENTIFICATIØN SEARCH
      DØ 504 I=1,7
      IF(RGØ-STRGØ(I)) 504,505,504
  504 CØNTINUE
      GØTØ 8086
  505 KGEØM=I
      IGEØM = 0
      IF (KGEØM.EQ.1.ØR.KGEØM.EQ.2.ØR.KGEØM.EQ.5.ØR.KGEØM.EQ.6) IGEØM =1
      IF (KGEØM.EQ.3) IGEØM=2
      IF(KGEØM.EQ.4) IGEØM=3
      IF ( KGEØM.EQ.7 ) IGEØM = 1
      DØ 506 I=1,3
      IF(TYPE-MATER(I))506,507,506
  506 CØNTINUE
      GØTØ 8087
  507 ITYPE=I
      DØ 510 I=1,12
      IF(INTERP-SEGTAB(I))510,511,510
  510 CØNTINUE
      GØ TØ 8088
  511 ISTTAB=I
      DØ 508 I=1,4
```

```
      IF (SHEET-FACE(I)) 508,5C9,508
  508 CØNTINUE
      GØTØ 8089
  509 THICK=I
C     TEMPERATURE LØAD IDENTIFICATIØN
      DØ 401 I=1,4
      IF(RANKIN.EQ.THERM(I))GØTØ 402
  401 CØNTINUE
      GØTØ 809C
  4C2 KELVIN=I
      KLUE2=1
      GØ TØ (430,430,420,420,420,420,425,425,425, 430,430,430),ISTTAB
  420 KLUE2=2
      GØ TØ 43C
  425 KLUE2=3
  430 KLUE1=THICK
C
C     LINEAR ANALYSIS IDENTIFICATIØN
      IANLYZ = 1
      NRØW = 3
      IF (THICK.GT.1) NRØW = THICK+3
      IF (ISTTAB.EQ.1) NRØW = 17
      IF (ISTTAB.EQ.3) NRØW = 19
      IF (ISTTAB.EQ.4) NRØW = 10
      IF (ISTTAB.EQ.5) NRØW = 12
      IF (ISTTAB.EQ.6) NRØW = 13
      IF (ISTTAB.EQ.7) NRØW = 9
      IF (ISTTAB.EQ.8) NRØW = 11
      IF (ISTTAB.EQ.9) NRØW = 12
      IF (ISTTAB.EQ.10) NRØW = 15
      IF (ISTTAB.EQ.11) NRØW = 17
      IF (ISTTAB.EQ.12) NRØW = 18
      NCØNT = NRØW
       DØ 901  I=1,NRØW
      READ(1)       (ST(I,J),J=1,NP)
  901 CØNTINUE
      DØ 750 JJ=1,12
  750 LST(JJ) = 0
      NLCS = NLCASE
      IF (IWØRD.GE.3) NLCS = NLCASE-1
      IF (NLCS.LE.0) GØ TØ 590
      K=NRØW+1
      JJ=1
      JJJ=6
      MM=1
      DØ 17 NLC=1,NLCS
      JT = JJ
      JTT= JJJ
      L=0
      READ(1) (LST(J),J=JJ,JJJ)
      IF(LST(JJ))8031,19,20
   20 L = LST(JJ)
      IF (NLC.GT.1.AND.LST(1).NE.C.AND.LST(JT).NE.0) GØ TØ 8008
   19 JJ=JJ+1
   23 IF(LST(JJ))8031,22,21
   21 L=L+1
   22 IF(JJ.EQ.JJJ) GØTØ 24
      JJ=JJ+1
      GØTØ 23
   24 IF(L.EQ.0) GØ TØ 71
      KK = K + L - 1
```

```
      DØ 72 M=K,KK                                                      1801900
      READ(1)        (ST(M,J),J=1,NP)                                   1801910
   72 CØNTINUE                                                          1801920
      IF (LST(JT).EQ.0) GØ TØ 660                                       1801930
      KZ = K + LST(1) -1                                                1801940
      K = KZ + 1                                                        1801950
  660 CØNTINUE                                                          1801960
   71 K = K + L - LST(JT)                                               1801970
      JJ=JJJ+1                                                          1801980
      JJJ=JJ+5                                                          1801990
   17 MM=MM+1                                                           1802C00
  590 CØNTINUE                                                          1802C10
      READ(1) IS,SAVJTC(IS),SAVSTP(IS),STØRY                            1802C20
      NSAVE = NRØW                                                      1802C30
      JJ = NLCASE*6                                                     1802C60
      LT=0                                                              1802C50
      DØ 15  J=1,JJ                                                     1802C60
   15 LT=LT+LST(J)                                                      1802C70
      NTØTAL=LT+NSAVE                                                   1802C80
      NEQNS=8*NPRØB                                                     1802C90
      TIC = ST(1,1)                                                     1802100
      STØP = ST(1,NP)                                                   1802110
      READ(4)    (YICS(I),I=1,NEQNS)                                    1802120
      NCYC=0                                                            1802130
      NSAVE=NRØW                                                        1802140
      IEND=0                                                            1802150
      PRINT=TIC                                                         1802160
      DTA=DTAU                                                          1802170
      DTAU=0.0                                                          1802180
      IF (NH.EQ.0) WRITE(6,656)                                         1802190
  656 FØRMAT(//5X,-PHI  ØR  S-,13X,-NTHETA-,11X,-NPHI-,11X,-ØMEGATH-)   1802200
      IF (NH.EQ.0.AND.NLCASE.EQ.2) WRITE(6,657)                         1802210
  657 FØRMAT(1H+,80X,-NTHETA-,11X,-NPHI-,11X,-ØMEGATH-)                 1802220
      IF (NH.NE.0) WRITE(6,671)                                         1802230
  671 FØRMAT(//27X,-V  E  C  T  Ø  R    1-,37X,-V  E  C  T  Ø  R    2-  1802260
     1 //3X,-PHI  ØR  S-,10X,-U-,14X,-V-,14X,-W-,9X,-ØMEGA THETA-,8X,   1802261
     2 -U-,14X,-V-,14X,-W-,9X,-ØMEGA THETA-/)                           1802262
      IF (NH.EQ.0) WRITE(6,661)                                         1802250
  661 FØRMAT(1X)                                                        1802260
      IF (NH.NE.0.AND.NLCASE.NE.0) READ(13) SAVY                        1802270
   59 CALL FIXEM (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME, 1802300
     1            DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)    1802310
      GØTØ  61                                                          1802320
   60 CALL WAND(MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,  1802330
     1           DTIME,YICS,YPRED,YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)     1802340
   61 IF(MAGØUT.LE.0) GØTØ 25                                           1802370
      IF (NH.EQ.0.AND.NLCASE.NE.0) WRITE(13) SAVY                       1802380
      IF(TIME.GT.STØP) GØTØ 62                                          1802390
      IF(TIME.LT.STØP) GØTØ 63                                          1802400
   64 IEND=-1                                                           1802410
      GØTØ 67                                                           1802420
   62 IF(TIME.LE.(STØP+DIFF)) GØTØ 64                                   1802430
      GØTØ 8001                                                         1802440
   63 IF((STØP-DIFF).LE.TIME) GØTØ 64                                   1802450
      IF((TIME+DTIME).GT.STØP) GØTØ 65                                  1802460
      IF(PRINT.GT.TIME) GØTØ 66                                         1802470
      PRINT=TIME+DTA                                                    1802480
   67 K2 = 1                                                            1802481
      IF (IWØRD.EQ.3.ØR.IWØRD.EQ.5) K2 = 2                              1802482
      IF(NH.EQ.0)WRITE(6,1333) TIME,((XSAVY(J1,K1),J1=1,3),K1=K2,NLCASE) 1802490
 1333 FØRMAT(1X,1PE16.7,2(5X,1P3E16.7))                                 1802500
```

```
      IF (NH.NE.0) WRITE(6,1334) TIME,RWØ                               1802510
 1334 FØRMAT(1X,1PE13.7,2(1X,1P3E15.7,1PE13.5))                         1802560
 6450 IF(IEND.GT.0) GØ TØ 8002                                          1802530
      IF(IEND.LT.0) GØTØ  150                                           1802540
   66 MAGIN=0                                                           1802550
      GØTØ 60                                                           1802560
   65 DTIME=STØP-TIME                                                   1802570
      DELTA=0.0                                                         1802580
      GØTØ 67                                                           1802590
   75 NCYC=NCYC+1                                                       1802600
      MAGIN=-1                                                          1802610
      GØTØ 60                                                           1802630
   25 PHI=TIME                                                          1802640
      ARG=PHI                                                           1802650
      IF (NH.NE.0.AND.KKNT.EQ.4.AND.NLCASE.NE.0) READ(13) SAVY          1802660
      LL=NP+1                                                           1802670
      DØ 51 I=1,NP                                                      1802680
      IF(ARG-ST(1,I)) 52,55,51                                          1802690
   52 IF(I-1) 55,55,54                                                  1802700
   51 CØNTINUE                                                          1802710
      I=NP                                                              1802720
      GØ TØ 55                                                          1802730
   54 DØ 57 IK=2,NTØTAL                                                 1802740
   57 ST(IK,LL)=ST(IK,I-1)+(ST(IK,I)-ST(IK,I-1))*(ARG-ST(1,I-1))/(ST(1,I 1802750
     1)-ST(1,I-1))                                                      1802760
      GØTØ 80                                                           1802770
   55 DØ 58 IK=2,NTØTAL                                                 1802780
   58 ST(IK,LL)=ST(IK,I)                                                1802790
   80 CØNTINUE                                                          1802800
C     THE UPDATED INTERPØLATED VALUES ØF THE MATERIAL PRØPERTY CØEFFIC  1802810
C     IENTS ARE FØUND IN THE XMAT TABLE AND STØRED IN THE XLAYER ARRAY  1802820
      L=(MAT-1)*2+1                                                     1802830
      II=NXMAT(L)                                                       1802840
       III=NXMAT(L+1)                                                   1802850
      LL=NP+1                                                           1802860
      L=NRØW + 1                                                        1802870
      IF(KELVIN .NE. 1)GØ TØ 81                                         1802880
      IF(THICK.NE.1)GØ TØ 83                                            1802890
   81 LØØP=1                                                            1802900
      ILØW=1                                                            1802910
      IHIGH = 1                                                         1802920
      IF(KELVIN .NE. 1)GØ TØ 85                                         1802930
   82 CØNTINUE                                                          1802940
      TMPAV(ILØW)=(ST(L,LL)+ ST(L+1,LL)+ ST(L+2,LL) + ST(L+3,LL))/4.0   1802950
      GØ TØ 85                                                          1802960
   83 LØØP = 2                                                          1802970
      ILØW= 1                                                           1802980
      IHIGH = 2                                                         1802990
      TMPAV(ILØW)= (ST(L,LL)+ ST(L+1,LL))/2.0                           1803000
      TMPAV(IHIGH)=(ST(L+2,LL) + ST(L+3,LL))/2.0                        1803010
   85 DØ 105 IL=ILØW,IHIGH                                              1803020
      M=1                                                               1803030
      GØTØ (91,92,93,93),KELVIN                                         1803040
   91 ARG= TMPAV(IL)                                                    1803050
      GØTØ 94                                                           1803060
   93 CØNTINUE                                                          1803070
      ARG = ST(NRØW+1,LL)                                               1803080
      TMPAV(1) = ARG                                                    1803090
   94 DØ 104 I = 2,10                                                   1803100
      IF (ARG-XMAT(II,I)) 121,123,104                                   1803110
  121 IF (I-2) 8007,8007,124                                            1803120
```

```
104 CØNTINUE                                                            1803130
    GØTØ 8067                                                           1803140
123 L=II+1                                                              1803150
    DØ 122 J=L,III                                                      1803160
    XLAYER(M)=XMAT(J,I)                                                 1803170
122 M=M+1                                                               1803180
    GØTØ 111                                                            1803190
124 L=II+1                                                              1803200
    DØ 125 J=L,III                                                      1803210
    XLAYER(M)=XMAT(J,I-1)+(XMAT(J,I)-XMAT(J,I-1))*(ARG-XMAT(II,I-1))/   1803220
   1          (XMAT(II,I)-XMAT(II,I-1))                                 1803230
125 M=M+1                                                               1803240
    GØTØ 111                                                            1803250
 92 L = II + 1                                                          1803260
    DØ 922  J=L,III                                                     1803270
    XLAYER(M)= XMAT(J,1)                                                1803280
922 M=M+1                                                               1803290
111 GØ TØ (115,115,112,113,114),LØØP                                    1803300
112 XNUTP= XLAYER(2)                                                    1803310
    IF(ITYPE.NE. 1)GØ TØ 131                                            1803320
    XNUPT= XNUTP                                                        1803330
    XGPT(1) = ETHET(1)/(2*(1+ XNUPT) )                                  1803340
    XGPT(2) = ETHET(2)/(2*(1+ XNUPT) )                                  1803350
    GØ TØ 106                                                           1803360
131 XNUTP = XLAYER(3)                                                   1803370
    XNUPT = ETHET(1)*XNUTP/EPHI(1)                                      1803380
    GØ TØ 106                                                           1803390
113 ES= XLAYER(8)                                                       1803400
    ALPHS=XLAYER(10)                                                    1803410
    GØ TØ 106                                                           1803420
114 ALPHR = XLAYER(9)                                                   1803430
    ER = XLAYER(7)                                                      1803440
    GØ TØ 118                                                           1803450
115 GØ TØ(101,102,103),ITYPE                                            1803460
101 ETHET(IL)= XLAYER(1)                                                1803470
    XNUTP    =XLAYER(2)                                                 1803480
    ALPHTH(IL)= XLAYER(3)                                               1803490
    EPHI(IL) = ETHET(IL)                                                1803500
    XNUPT= XNUTP                                                        1803510
    ALPHPH(IL)= ALPHTH(IL)                                              1803520
    XGPT(IL)= ETHET(IL)/(2.0*(1.0+ XNUPT))                              1803530
    GØ TØ 105                                                           1803540
102 ETHET(IL)= XLAYER(1)                                                1803550
    EPHI(IL) = XLAYER(2)                                                1803560
    XNUTP = XLAYER(3)                                                   1803570
    ALPHTH(IL)= XLAYER(4)                                               1803580
    ALPHPH(IL)= XLAYER(5)                                               1803590
    XGPT(IL) = XLAYER(6)                                                1803600
    XNUPT= ETHET(IL)* XNUTP/EPHI(IL)                                    1803610
    GØ TØ 105                                                           1803620
103 ETHET(IL)= XLAYER(1)                                                1803630
    EPHI(IL)= XLAYER(2)                                                 1803640
    XNUTP= XLAYER(3)                                                    1803650
    ALPHTH(IL) = XLAYER(4)                                              1803660
    ALPHPH(IL) = XLAYER(5)                                              1803670
    XGPT(IL) = XLAYER(6)                                                1803680
    ER= XLAYER(7)                                                       1803690
    ES =XLAYER(8)                                                       1803700
    ALPHR = XLAYER(9)                                                   1803710
    ALPHS = XLAYER(10)                                                  1803720
    XNUPT = ETHET(IL) * XNUTP/EPHI(IL)                                  1803730
```

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105 CØNTINUE                                                             1803740
106 L = NRØW+1                                                           1803750
    GØ TØ (117,107,108,281,118),LØØP                                     1803760
107 LØØP= 3                                                              1803770
    ILØW = 3                                                             1803780
    IHIGH= 3                                                             1803790
    GØ TØ 82                                                             1803800
108 IF(ITYPE .EQ.3 .AND. ISTTAB .GE. 3)GØ TØ 109                         1803810
    GØ TØ 118                                                            1803820
109 LØØP= 4                                                              1803830
    ILØW =4                                                              1803840
    IHIGH = 4                                                            1803850
    CPH = ST(3,LL)                                                       1803860
    IF(ISTTAB.GE. 10.AND. ISTTAB.LE. 12)CPH = ST(6,LL)                   1803870
    IF(CPH     .LE.0)GØ TØ 284                                           1803880
    TMPAV(4)= ST(L,LL)                                                   1803890
    GØ TØ 85                                                             1803900
284 TMPAV(4) =ST(L+3,LL)                                                 1803910
    GØ TØ 85                                                             1803920
281 LØØP=5                                                               1803930
    ILØW=5                                                               1803940
    IHIGH=5                                                              1803950
    CTH = ST(3,LL)                                                       1803960
    IF(ISTTAB .GE. 10 .AND. ISTTAB .LE. 12)CTH = ST(7,LL)                1803970
    IF(CTH     .LE. 0)GØ TØ 116                                          1803980
    TMPAV(5)= ST(L,LL)                                                   1803990
    GØ TØ 85                                                             1804000
116 TMPAV(5)= ST(L+3,LL)                                                 1804010
    GØ TØ 85                                                             1804020
117 CØNTINUE                                                             1804030
    ETHET(2)= ETHET(1)                                                   1804040
    ALPHTH(2)=ALPHTH(1)                                                  1804050
    ALPHPH(2)=ALPHPH(1)                                                  1804060
    XGPT(2)= XGPT(1)                                                     1804070
    EPHI(2)= EPHI(1)                                                     1804080
118 CØNTINUE                                                             1804090
    CALL TØBAR (ST,KLUE2,NRØW,LL,ER,ES,E1,E2,HI,HØ,T,TII,TØØ,TIK,TØK,    1804100
   1            DEGRES,G2,G3,TIME,NCØNT)                                 1804110
    IF (NIX.NE.0) GØ TØ 9999                                             1804120
    LL=NP+1                                                              1804130
    IF(XK11.EQ.0.0) GØTØ 8101                                            1804140
    IF(ITYPE.EQ.3.AND.XK12.EQ.0.) GØ TØ 8102                             1804150
    IF(ITYPE.EQ.3.AND.XK21.EQ.0.) GØ TØ 8103                             1804160
    IF(XK22.EQ.0.0) GØTØ 8104                                            1804170
    IF(XK33.EQ.0.0) GØTØ 8105                                            1804180
    IF(XD11.EQ.0.0) GØTØ 8106                                            1804190
    IF(ITYPE.EQ.3.AND.XD12.EQ.0.) GØ TØ 8107                             1804200
    IF(ITYPE.EQ.3.AND.XD21.EQ.0.) GØ TØ 8108                             1804210
    IF(XD22.EQ.0.0) GØTØ 8109                                            1804220
    IF(XD33.EQ.0.0) GØTØ 8110                                            1804230
    NL=0                                                                 1804240
    XNPHI = 0.0                                                          1804250
    JF = NPRØB                                                           1804260
    K = NRØW                                                             1804270
    NLCSE = NLCASE
    IF (NH.EQ.0) NLCSE = 1
    XFPHL1 = 0.0
    XFZEL1 = 0.0
    XFPHL2 = 0.0
    XFZEL2 = 0.0
    DØ 7 M=1,JF                                                          1804280
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      I = (M-1)*8 + 1                                                   1804290
      IF (NH.EQ.0) GØ TØ 350
      K = NRØW
      NL = 0
  350 CØNTINUE
      DØ 250 JKL=1,NLCSE
      IF (JKL.EQ.2.ØR.(M.EQ.2.AND.NH.EQ.0).ØR.IWØRD.EQ.3.ØR.IWØRD.EQ.5) 1804410
     1   GØ TØ 148                                                      1804411
      NL=NL+1                                                           1804300
      XFTHLD=0.0                                                        1804310
      XFPHLD=0.0                                                        1804320
      XFZELD=0.0                                                        1804330
      XMTHLD=0.0                                                        1804340
      XMPHLD=0.0                                                        1804350
      IR=NL*6-5                                                         1804370
      IF(LST(IR).NE.0) K=K+LST(IR)                                      1804380
      IF (LST(IR+1).EQ.0) GØTØ 44                                       1804390
      K=K+1                                                             1804400
      XFTHLD=ST(K,LL)                                                   1804410
   44 IF(LST(IR+2).EQ.0) GØTØ 45                                        1804420
      K=K+1                                                             1804430
      XFPHLD=ST(K,LL)                                                   1804440
   45 IF(LST(IR+3).EQ.0) GØTØ 46                                        1804450
      K=K+1                                                             1804460
      XFZELD=ST(K,LL)                                                   1804470
   46 IF(LST(IR+4).EQ.0) GØTØ 47                                        1804480
      K=K+1                                                             1804490
      XMTHLD=ST(K,LL)                                                   1804500
   47 IF(LST(IR+5).EQ.0) GØTØ 48                                        1804510
      K=K+1                                                             1804520
      XMPHLD=ST(K,LL)                                                   1804530
   48 CØNTINUE                                                          1804540
      GØ TØ 149
  148 XFTHLD = 0.0
      XFPHLD = XMERD
      XFZELD = XPRES
      XMTHLD = XMØNT
      XMPHLD = 0.0
  149 CØNTINUE
      IF (JKL.EQ.2) GØ TØ 251
      XFPHL1 = XFPHLD
      XFZEL1 = XFZELD
  251 XFPHL2 = XFPHLD
      XFZEL2 = XFZELD
  250 CØNTINUE
      IF (ISTTAB.GE.3.AND.ISTTAB.LE.9) GØ TØ 4002                       1804550
      CALL ØDE1 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)                           1804560
      GØ TØ 77                                                          1804570
 4002 CALL ØDE2 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)                           1804580
   77 IF (NH.NE.0) GØ TØ 8                                              1804590
      NN = (M-1)*3+1                                                    1804600
      IF (IWØRD.EQ.3.ØR.IWØRD.EQ.5) NN = 4                              1804601
      SAVY(NN) = YANTH                                                  1804610
      SAVY(NN+1) = YPRED(I+1)                                           1804620
      SAVY(NN+2) = YPRED(I+7)                                           1804630
      GØ TØ (177,178,179),IGEØM
  177 SAVY(M+6) = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      GØ TØ 7
  178 SAVY(M+6) = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1             YPRED(I+6))
      GØ TØ 7
```

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  179 SAVY(M+6) = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      GØ TØ 7                                                  1804640
    8 N = 1
      IF (M.EQ.2) N = 5
      RWØ(N) = YPRED(I+4)
      RWØ(N+1) = YPRED(I+5)
      RWØ(N+2) = YPRED(I+6)
      RWØ(N+3) = YPRED(I+7)
    7 CØNTINUE                                                 1804690
      GØTØ 75                                                  1804700
 8001 IERRØR=8001                                              1804710
      NERRØR = 11                                              1804720
      GØTØ 8888                                                1804730
 8002 IERRØR=8002                                              1804740
      NERRØR = 12                                              1804750
      GØTØ 8888                                                1804760
 8007 IERRØR=8007                                              1804770
      NERRØR = 15                                              1804780
      GØTØ 8888                                                1804790
 8008 IERRØR = 8008                                            1804800
      NERRØR = 10                                              1804810
      GØ TØ 8888                                               1804820
 8031 IERRØR=8031                                              1804830
      NERRØR = 9                                               1804840
      GØTØ 8888                                                1804850
 8036 IERRØR=8036                                              1804860
      NERRØR = 2                                               1804870
      GØTØ 8888                                                1804880
 8086 IERRØR=8086                                              1804890
      NERRØR = 3                                               1804900
      GØTØ 8888                                                1804910
 8087 IERRØR=8087                                              1804920
      NERRØR = 4                                               1804930
      GØTØ 8888                                                1804940
 8088 IERRØR=8088                                              1804950
      NERRØR = 27                                              1804960
      GØTØ 8888                                                1804970
 8089 IERRØR=8089                                              1804980
      NERRØR = 5                                               1804990
      GØTØ 8888                                                1805000
 8090 IERRØR=8090                                              1805010
      NERRØR = 6                                               1805020
      GØTØ 8888                                                1805030
 8067 IERRØR= 8067                                             1805040
      NERRØR = 16                                              1805050
      GØTØ 8888                                                1805060
 8101 IERRØR = 8101                                            1805070
      NERRØR = 17                                              1805080
      GØTØ 8888                                                1805090
 8102 IERRØR = 8102                                            1805100
      NERRØR = 18                                              1805110
      GØTØ 8888                                                1805120
 8103 IERRØR = 8103                                            1805130
      NERRØR = 19                                              1805140
      GØTØ 8888                                                1805150
 8104 IERRØR = 8104                                            1805160
      NERRØR = 20                                              1805170
      GØTØ 8888                                                1805180
 8105 IERRØR = 8105                                            1805190
      NERRØR = 21                                              1805200
      GØTØ 8888                                                1805210
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8106 IERRØR = 8106
     NERRØR = 22
     GØTØ 8888
8107 IERRØR = 8107
     NERRØR = 23
     GØTØ 8888
8108 IERRØR = 8108
     NERRØR = 24
     GØTØ 8888
8109 IERRØR = 8109
     NERRØR = 25
     GØTØ 8888
8110 IERRØR = 8110
     NERRØR = 26
8888 NIX=1
     GØ TØ 9999
 150 IF(LSC.LT.KSC) GØ TØ 902
9999 RETURN
      END
```

```
FØR,IS FIXEM,FIXEM
      SUBRØUTINE FIXEM (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,
     1                  EPSIL,DELTA,ERR,TIME,DTIME,YICS,YPRED,
     2                  YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)
C     RUNGE KUTTA MAGIC (REVISED)  SINGLE PRECISIØN         FØRTRAN IV
      DIMENSIØN YICS( 1),YPRED( 1),YCØRR( 1), YDØT( 1), YNEW( 1),
     1          YDEV(1),FWDEL(1),TBDEL(1)
      DIMENSIØN C(3),D(3)
      CØMMØN /MAGIQ/ KKNT
      DØUBLE PRECISIØN YNEW,YPRED
      DØUBLE PRECISIØN TIC,STEP,DTAU,DELTA,TIME,DTIME
      DATA C,D / .5,.5,1.0,.5,.0,.5/
      TIME = TIC
      TAU  = TIC
      IF (DELTA)200,201,200
  200 DTIME = 0.0078125
      GØ TØ 225
  201 DTIME = STEP
  225 DØ 102 I = 1,NEQNS
      YDEV(I)  = 0.0
      YPRED(I) = YICS(I)
      YCØRR(I) = YICS(I)
  102 YNEW(I)  = YICS(I)
      MAGØUT   =-2
      GØ TØ 264
 5555 CØNTINUE
      ENTRY WAND (MAGIN,MAGØUT,TIC,STEP,NEQNS,DTAU,
     1                  EPSIL,DELTA,ERR,TIME,DTIME,YICS,YPRED,
     2                  YCØRR,YDØT,YNEW,YDEV,FWDEL,TBDEL)
 5556 CØNTINUE
      IF (MAGØUT) 305,101,101
  101 IF(MAGIN) 21, 27, 14
   27 K = 0
      DØ 202 I = 1,NEQNS
  202 YNEW(I)  = YPRED(I)
   21 K = K +1
      KKNT = K
  210 DØ  2  I = 1,NEQNS
      GØ TØ (9,6,7,4,11),K
    9 FWDEL(I) = YDØT(I)
      GØ TØ 105
    6 TBDEL(I) = YDØT(I)
      GØ TØ 105
    7 TBDEL(I) = TBDEL(I) + YDØT(I)
  105 YPRED(I) = YNEW(I) + C(K)*DTIME*YDØT(I)
      GØ TØ (2,2,400),K
  400 YCØRR(I) = YPRED(I)
    2 CØNTINUE
      TIME     = TIME + D(K)*DTIME
   99 MAGØUT   = 0.0
  264 RETURN
    4 DØ  8  I = 1,NEQNS
      YPRED(I) = YNEW(I) + DTIME*(FWDEL(I) + 2.*TBDEL(I) + YDØT(I))/6.
    8 YDEV(I)  = YCØRR(I) - YPRED(I)
      GØ TØ 99
   11 IF (DELTA)80, 5,80
   80 DØ   13 I = 1,NEQNS
      IF (EPSIL*ABS(YCØRR(I)) + ERR - ABS(YDEV(I))) 14,13,13
   13 CØNTINUE
      IF (SIGB)15,15,205
  205 SIGB = 0.0
```

```
      GØ TØ 5
   15 SIGB = 0.0
      DØ 207 I = 1,NEQNS
      IF (ERR  /100.+ DELTA*ABS(YCØRR(I)) - ABS(YDEV(I))) 5,207,207
  207 CØNTINUE
      DTIME    = 2.*DTIME
    5 DØ 208 I = 1,NEQNS
  208 YCØRR(I) = YPRED(I)
  305 IF (DTAU) 19,30,19
   19 IF (TAU - TIME)20,20,27
   20 TAU = TAU + DTAU
   30 MAGØUT = 2
      GØ TØ 264
   14 DTIME = DTIME/2.0
   25 IF (K-3)48,26,26
   26 TIME  = TIME - DTIME - DTIME
      GØ TØ 47
   48 TIME  = TIME - DTIME
   47 SIGB     = +2.
      DØ 209 I = 1,NEQNS
  209 YDØT(I) = FWDEL(I)
  212 K        = 0
      GØ TØ 21
       END
```

```
FØR,IS TØBAR,TØBAR
      SUBRØUTINE TØBAR (ST,KLUE2,NRØW,LL,ER,ES,E1,E2,HI,HØ,T,TII,TØØ,
     1                  TIK,TØK,DEGRES,G2,G3,TIME,NCØNT)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN2,XN
      REAL*4 I2
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YPRED,TIME
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XKL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),
     1               YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,
     2               S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3               X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4               X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5   RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,
     6               XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),
     8               XNUTP,XNUPT,XC11,XC22,XC15,XC33,XD22,XD21,XD12,
     9               XK11,XK12,XK21,XK22,XK33,XD11,
     A                  M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,
     B            ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH
     C               ,XNPHI,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /SNILPS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1      DR1DP(100),ZI(14),RI(14),NRZIN
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      DIMENSIØN ST(72,31)
      DATA A/-A   -/
      GØTØ (771,772,773,774,775,776,7077),KGEØM
C     GEØMETRY FØR ELIPSE(G3=ØFFSET DISTANCE )
  771 A=G1
      BE=G2
      BETA = BE
       BESQ=BE**2
      ASQ=A**2
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      SNSQ = SN**2
      CSSQ = CS**2
      R2 = A*SQRT(1.0/(SNSQ+BESQ*CSSQ))
      R2SQ = R2**2
      RØ=R2*SN
      R1=R2*R2SQ*BESQ/ASQ
      BESQ=BE**2
      R1DØT=0.C
      IF(KGEØM.EQ.1.AND.BETA.NE.1.0.AND.SN.NE.0.0)R1DØT=3.0*(R2*BETA/
     1A) **2*(CS/SNSQ)*(R1*SN-RØ)
      IF(SN.EQ. 0.0)GØ TØ 779
      R2 = R2-G3/SN
      R2SQ = R2**2
      RØ = RØ-G3
      GØ TØ 7775
  779 IF(G3 .EQ. 0.0)GØ TØ 7775
      R1DØT = 3.0*G3
      RØ = -G3
      GØ TØ 7775
```

```
C     GEØMETRY FØR ØGIVE
  772 R1=G1
      C=G2
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      IF (SN.EQ.0.0) GØTØ 777
      R2=R1-C/SN
      GØTØ 778
  777 R2 = 1.0
  778 RØ = R1*SN-C
      R1DØT=0.0
      GØTØ 7775
C     GEØMETRY FØR CØNE
  773 CS = CØS(G1)
      SN=SIN(G1)
      S=PHI
      S1=1.0/S
      R2=CS*SN*PHI
      RØ=PHI*CS
      R1DØT=0.0
      GØTØ 7775
C     GEØMETRY FØR CYLINDER
  774 RØ = G1
      SN=1.0
      CS=1.0
      R1DØT=0.0
      GØTØ 7775
C   MØDIFIED  ELLIPSE
  775 XNEXP=G1
      A   =G2
      XN1=1.0+XNEXP
      XN2=1.0/XN1
      XN3=XN1+1.0
      XN4=XN3+1.0
      XN5=XN4/XN1
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      R2= A*(2.0/(1.0+SN**XN1))**XN2
      R1=(A/2.0)*(R2/A)**XN3
      RØ=R2*SN
      R1DØT=-XN3*A*(SN**XNEXP*CS/4.0)*(2.0/(1.0+SN**XN1))**XN5
      GØTØ 7775
C     GENERAL GEØMETRY
  776 SN = DSIN(PHI)
      CS = DCØS(PHI)
      TAN = SN / CS
      SEC = 1.0 / CS
      IF (TIME.EQ.TIC) CALL TEMØEG
      ARG = PHI
      DØ 204 J=1,100
      PHØ = PSI(J)
      IF (ANG.EQ.A) IF (ARG-PHØ) 221,223,204
      IF (PHØ-ARG) 221,223,204
  221 IF (J-1) 8502,8502,224
  204 CØNTINUE
      GØ TØ 8503
  223 RØ = RAD(J)
      R1 = CUR1(J)
      R2 = CUR2(J)
      R1DØT = DR1DP(J)
      GØ TØ 7775
```

```
 8502 NERRØR = 41
      GØ TØ 8888
 8503 NERRØR = 42
 8888 NIX = 1
      GØ TØ 8889
  224 SUB1 = ARG-PSI(J-1)
      SUB2 = PSI(J)-PSI(J-1)
      RØ = RAD(J-1)+(RAD(J)-RAD(J-1))*SUB1/SUB2
      R1 = CUR1(J-1)+(CUR1(J)-CUR1(J-1))*SUB1/SUB2
      R2 = CUR2(J-1)+(CUR2(J)-CUR2(J-1))*SUB1/SUB2
      R1DØT = DR1DP(J-1)+(DR1DP(J)-DR1DP(J-1))*SUB1/SUB2
      GØTØ 7775
C     ISØTENSØID GEØMETRY
 7077 CØNTINUE
      SN = DSIN(PHI)
      CS = DCØS(PHI)
      A  = G1
      R2 = A / SQRT(SN)
      R1 = 0.5 * R2
      RØ = R2 * SN
      R1DØT = - ((A**2)*0.5)*(R1*CS)/RØ**2
 7775 TAN=SN/CS
      DEGRES  = 0.0
      IF(IGEØM.EQ.1) DEGRES = PHI * 57.29578
      RØSQ = RØ**2
      XNSQ=XN**2
      CN=CS*SN
      X1CS=1.0/CS
      TN=SN/CS
      X1RØ=1.0/RØ
      X1RØSQ=1.0/RØ**2
      X1CSRØ=1.0/(CS*RØ)
      CN1RØ=CN/RØ
      SN1RØ=SN/RØ
      CS1RØ=CS/RØ
      SNSQ=SN**2
      CSSQ=CS**2
      IF(KGEØM.EQ.4.ØR.KGEØM.EQ.3) GØTØ 79
      R1SQ = R1**2
      R2SQ = R2**2
      X1SN=1.0/SN
      X1SNRØ=1.0/(SN*RØ)
      X1R1=1.0/R1
      X1R2=1.0/R2
      CS1R1=CS/R1
      CS1R2=CS/R2
      SN1R1=SN/R1
      X1R1SQ=1.0/R1**2
   79 XNTTH=0.C
      XNTPH=0.0
      XMTTH=0.0
      XMTPH=0.C
C
C     CØMPUTATIØN ØF K AND D FØR MATERIAL PRØPETY INPUT
C
      HØ = 0.0
      T = 0.0
      HI = 0.0
      RHØR = 0.0
      RHØS = 0.0
      RHØI = 0.0
```

```
      RHØC = 0.0
      CTH = 0.C
      CPH = 0.0
      YBARI = 0.0
      YBARC = C.0
      YBARØ = C.0
      AA = 0.0
      GØ TØ (711,600,711,32,33,34,35,36,37,28,29,30),ISTTAB
C     THICK
  600 GØ TØ (7C3,702,701,701),THICK
  701 HØ= ST(4,LL)
  702 T = ST(3,LL)
      RHØC = ST(NCØNT-1,LL)
  703 HI= ST(2,LL)
      RHØI = ST(NCØNT,LL)
      GØ TØ 40
C     ST11,ST12,ST13
   30 HØ= ST(14,LL)
   29 T = ST(13,LL)
      RHØC = ST(NCØNT-3,LL)
   28 HI= ST(12,LL)
      RHØI = ST(NCØNT-2,LL)
      RHØS = ST(NCØNT-1,LL)
      RHØR = ST(NCØNT,LL)
      GJPH= ST(2,LL)
      GJTH= ST(3,LL)
      APH = ST(4,LL)
      ATH = ST(5,LL)
      CPH = ST(6,LL)
      CTH = ST(7,LL)
      XIPH = ST(8,LL)
      XITH= ST(9,LL)
      SPH = ST(10,LL)
      STH = ST(11,LL)
      AA = RHØR*XITH+RHØS*XIPH
      GØ TØ 40
C     RWAF1,RWAF2,RWAF3
   34 HØ = ST(10,LL)
   33 T = ST(9,LL)
      RHØC = ST(NCØNT-2,LL)
   32 HI = ST(8,LL)
      RHØI = ST(NCØNT-1,LL)
      RHØS = ST(NCØNT,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH= ST(4,LL)
      SPH = ST(5,LL)
      BETTA=ST(6,LL)
      ZETTA = ST(7,LL)
      ATH = APH
      CTH = CPH
      XITH= XIPH
      STH = SPH
      RHØR = RHØS
      AA = RHØS*XITH
      GØ TØ 40
C     ISG1,ISG2,ISG3
   37 HØ = ST(9,LL)
   36 T = ST(8,LL)
      RHØC = ST(NCØNT-2,LL)
   35 HI = ST(7,LL)
```

```
      RHØI = ST(NCØNT-1,LL)
      RHØS = ST(NCØNT,LL)
      APH = ST(2,LL)
      CPH = ST(3,LL)
      XIPH = ST(4,LL)
      SPH = ST(5,LL)
      BETTA = ST(6,LL)
      ATH = APH
      CTH = CPH
      XITH = XIPH
      STH = SPH
      RHØR = RHØS
      AA = RHØS*XITH
      GØ TØ 40
C     ST10,RWAF
C     RANKIN=THSTND MEANS INTERPØLATE,CØMPUTE NTEMP,MTEMP
C     RANKIN=NØTHRM MEANS DØ NØT INTERPØLATE,DØ NØT CØMPUTE NTEMP,NTEMP
C     RANKIN=THCNST MEANS DØ NØT AVERAGE, BUT INTERPØLATE,CØMPUTE
C                                                     NTEMP, MTEMP
C     RANKIN=THINHØ MEANS INTERPØLATE,BUT DØ NØT CØMPUTE NTEMP,MTEMP
C
  711 CØNTINUE
      XK11=ST(2,LL)
      XK12=ST(3,LL)
      XK22 = ST(4,LL)
      XK33 = ST(5,LL)
      XD11 = ST(6,LL)
      XD12 = ST(7,LL)
      XD22 = ST(8,LL)
      XD33 = ST(9,LL)
      XC11 = ST(10,LL)
      XC22 = ST(11,LL)
      XC15 = ST(12,LL)
      XC16 = ST(13,LL)
      XMERD = ST(NCØNT-5,LL)
      XPRES = ST(NCØNT-4,LL)
      XMØNT = ST(NCØNT-3,LL)
      AZERØ = ST(NCØNT-2,LL)
      AØNE = ST(NCØNT-1,LL)
      ATWØ = ST(NCØNT,LL)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 103
C
   40 CØNTINUE
      TEMP3= (1.0-XNUPT * XNUTP)
      PERM= TEMP3
      E1= (ETHET(1)+ EPHI(1))/2.
      E2= (ETHET(2)+ EPHI(2))/2.
      ES1= E1+E2
      GØ TØ (42,47,49,41),THICK
   41 GØ TØ (103,42,103,42,47,49,42,47,49,42,47,49),ISTTAB
C
C     SINGLE SHEET
C
   42 TEMP1= ETHET(1) * HI
      TEMP2= TEMP1 * HI**2
      XK11= TEMP1/TEMP3
      XD11= TEMP2/(12.0* TEMP3)
      TEMP1= EPHI(1)* HI
      TEMP2= TEMP1*HI**2
```

```
      XK22= TEMP1/TEMP3
      XD22= TEMP2/(12.0* TEMP3)
      XK33= XGPT(1)* HI
      XD33= XK33*HI**2/12.0
      YBARI = 0.0
      YBARC = 0.0
      YBARØ = 0.0
      ATHR = RHØI*HI**3/12.0
      GØ TØ 55
C
C     EQUAL SHEETS
C
   47 EPSUM= EPHI(1)+ EPHI(2)
      ETSUM= ETHET(1)+ ETHET(2)
      XK11= ETSUM * HI/PERM
      XK22= EPSUM * HI/PERM
      XK33= HI*(XGPT(1)+ XGPT(2))
      ZBRIN = (HI*(E1+3.0*E2)+2.0*E2*T)/(2.0*ES1)
      ZBRØUT = (HI*(E2+3.0*E1)+2.0*E1*T)/(2.0*ES1)
      ZBHIN= (ZBRIN- HI/2.0)**2
      ZBHØUT=(ZBRØUT-HI/2.0)**2
      XD33= (HI**3*(XGPT(1)+XGPT(2)))/12.0+ HI*(XGPT(1)* ZBHIN
     1     +  XGPT(2)* ZBHØUT)
      XD11=(XK11* HI**2)/12.+ HI*( ETHET(1) * ZBHIN + ETHET(2)*ZBHØUT)
     1/PERM
      XD22=(XK22* HI**2)/12.+ HI*( EPHI(1) * ZBHIN + EPHI(2)* ZBHØUT)
     1/PERM
      YBARI = ZBRIN-HI/2.0
      YBARC = ZBRIN-HI-T/2.0
      YBARØ = HI/2.0-ZBRØUT
      ATHR = (RHØC*T**3+RHØI*2.0*HI**3)/12.0+RHØI*HI*(ZBHIN+ZBHØUT)
      GØ TØ 55
C
C     UNEQUAL FACE SHEETS
C
   49 CØNTINUE
      ZBRIN =((E1*HI**2)+(E2*HØ**2) +(2.0*E2*HØ*HI) +(2.0*E2*HØ*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBRØUT=((E1*HI**2)+(E2*HØ**2) +(2.0*E1*HØ*HI) +(2.0*E1*HI*T)) /
     1 (2.0*(E1*HI+E2*HØ))
      ZBHIN =(ZBRIN-HI/2.0)**2
      ZBHØUT =(ZBRØUT-HØ/2.0)**2
      XK11= (ETHET(1)* HI + ETHET(2)* HØ)/PERM
      XK22= (EPHI(1) * HI + EPHI(2) * HØ)/PERM
      XK33= XGPT(1)*HI + XGPT(2) * HØ
      XD33 = (XGPT(1)*HI**3+XGPT(2)*HØ**3)/12.+HI*(XGPT(1)*ZBHIN)+
     1 XGPT(2)*ZBHØUT*HØ
      D11 =  (ETHET(1)*HI**3 + ETHET(2)*HØ**3)/12.
      XD11=(D11+ (HI*ETHET(1)*ZBHIN)   + (HØ*ETHET(2)*ZBHØUT))/PERM
      D22 =  (EPHI(1)* HI**3 + EPHI(2)*HØ**3)/12.
      XD22=.( D22 +(HI*EPHI(1)*ZBHIN) + (HØ*EPHI(2)* ZBHØUT)) /PERM
      YBARI = ZBRIN-HI/2.0
      YBARC = ZBRIN-HI-T/2.0
      YBARØ = HØ/2.0-ZBRØUT
      ATHR = (RHØC*T**3+RHØI*(HI**3+HØ**3))/12.0+RHØI*(HI*ZBHIN+
     1       HØ*ZBHØUT)
C
C     DETERMINE CØMPLETE CØNSTANTS DEPENDENT ØN REINFØRCEMENT CLUE
C
   55 CØNTINUE
      RØI = RØ-YBARI*SN
```

```
      RØU = RØ-YBARØ*SN
      RØC = RØ-YBARC*SN
      IF (THICK.EQ.2) HØ = HI
      IF (ISTTAB.EQ.5.ØR.ISTTAB.EQ.8.ØR.ISTTAB.EQ.11) HØ = HI
      D3 = RHØI*RØI*HI
      D4 = RHØC*RØC*T
      D5 = RHØI*RØU*HØ
      C3 = RHØI*HI
      C4 = RHØC*T
      C5 = RHØI*HØ
      DD = D3+D4+D5
      CC = C3+C4+C5
      XMERD = DD*ØMEGA*CS
      XPRES = -DD*ØMEGA*SN
      XMØNT = -(D3*YBARI+D4*YBARC+D5*YBARØ)*ØMEGA*CS
      AZERØ = CC
      AØNE = C3*YBARI+C4*YBARC+C5*YBARØ
      IF(ISTTAB .EQ.2)GØ TØ 103
      TBARR = ATH/STH
      TBARS = APH/SPH
      RØR = RØ-CTH*SN
      RØS = RØ-CPH*SN
      EASTH=ER*ATH/STH
      EASPH=ES*APH/SPH
      EISPH= ES* XIPH/SPH
      EISTH= ER* XITH/STH
      D1 = RHØR*RØR*TBARR
      D2 = RHØS*RØS*TBARS
      C1 = RHØR*TBARR
      C2 = RHØS*TBARS
      DD = D1+D2+D3+D4+D5
      CC = C1+C2+C3+C4+C5
      GØ TØ (58,60,100),KLUE2
C
C     ST CLUE (11,12,13)
C
   58 CØNTINUE
      XK12= XK11*XNUTP
      XK11= XK11+ EASTH
      XK22= XK22+ EASPH
      XC11= EASTH*CTH
      XC22= EASPH*CPH
      XD22 = -XD22-EISPH
      XD33= XD33 + GJPH/(4.0*SPH)+ GJTH/(4.0*STH)
      XD12= -XD11*XNUTP
      XD11= -XD11- EISTH
      XK21 = XK12
      XD21 = XD12
      XMERD = DD*ØMEGA*CS
      XPRES = -DD*ØMEGA*SN
      XMØNT = -(D1*CTH+D2*CPH+D3*YBARI+D4*YBARC+D5*YBARØ)*ØMEGA*CS
      AZERØ = CC
      AØNE = C1*CTH+C2*CPH+C3*YBARI+C4*YBARC+C5*YBARØ
      GØ TØ 103
C     RWA CLUE (1,2,3)
C
   60 CØNTINUE
      SINB =SIN(BETTA)
      CØSB =CØS(BETTA)
      SN2TØ4 = 2*(SINB**4.)
      D= STH*(CØSB+SINB)
```

```
      ED = ER*ATH/D
      SINB2= SINB**2.
      HL = 2.0*(ABS(ZETTA)-ABS(CTH))
      I2=(ATH**3.)/(3* HL**2)
   95 XC22 = 2.0*CTH*CØSB**3*ED
      XC15 = 2.0*CTH*CØSB*SINB2*ED
      XC16 = XC15
      GRI=  ER* I2/(2.0*(1.0 + XNUTP)*D)
      XC11 = CTH*SN2TØ4/CØSB*ED
      EDI = ER*XITH/D
      SN4TØ2 = 4.*SINB2
      XD22 = -XD22-2.0*CØSB**3*EDI-SN4TØ2*CØSB*GRI
      TB= 2.0* BETTA
      XD33 = XD33+((4.0*CØS(TB)*
     1*2*GRI)/ CØSB) + (2.0*CØSB*SINB2*EDI)
      XD12 = -XD11*XNUTP-(2.0*CØSB
     1*SINB2*EDI)-(SN4TØ2*CØSB*GRI )
      XK12= XK11*XNUTP + (2.0*CØSB*SINB2*ED)
      XK22=XK22+(2*CØSB**3*ED)
      XK33=XK33+(2*CØSB*SINB2*ED)
      XK11=XK11+(SN2TØ4*ED/CØSB)
      XD11 = -XD11-SN2TØ4*EDI/CØSB-(
     1 SN4TØ2*CØSB*GRI)
      XK21 = XK12
      XD21 = XD12
      GØ TØ 108
C
C     ISG CLUE (1,2,3)
C
  100 CØNTINUE
      SNB =SIN(BETTA)
      CSB =CØS(BETTA)
      TBETTA= 2.0*BETTA
      CS2B= CØS(TBETTA)
      ØNEC2B=(1.0+ CS2B)/2.
      SCB2  =(SNB-CS2B*SNB + 2.)/(2.0*CSB)
      SN2B  =SIN(TBETTA) /2.
      XK12=XK11*XNUTP + (EASTH*SNB*ØNEC2B/CSB)
      XK11=XK11+ EASTH*SCB2
      XK22=XK22+ EASTH*(CSB/SNB*ØNEC2B)
      XK33=XK33+ EASTH* SN2B
      XC11=      (EASTH*CTH* SCB2 )
      XC15=EASTH*CTH*( SNB* ØNEC2B/CSB )
      XC16=EASTH*CTH*SN2B
      XC22= EASTH*CTH* (CSB/SNB * ØNEC2B)
      XD12=-XD11*XNUTP- EISTH*(SNB*ØNEC2B/CSB)
      XD11=-XD11- EISTH*SCB2
      XD22 = -XD22-EISTH*(CSB/SNB*ØNEC2B)
      XD33= XD33+ EISTH*SN2B
      XK21 = XK12
      XD21 = XD12
C
C
  108 XMERD = (DD-D2)*ØMEGA*CS
      XPRES = -(DD-D2)*ØMEGA*SN
      XMØNT = -(D1*CTH+D3*YBARI+D4*YBARC+D5*YBARØ)*ØMEGA*CS
      AZERØ = CC-C2
      AØNE = C1*CTH+C3*YBARI+C4*YBARC+C5*YBARØ
C
  103 CØNTINUE
      IF (KGEØM.NE.4) GØ TØ 105
```

```
      XMERD = C.0
      XMØNT = C.0
  105 CØNTINUE
      IF(ISTAB.NE.1.AND.ISTAB.NE.3) ATWØ=AA+ATHR
C
      GØTØ (716,714,715,714),KELVIN
  716 TII = ST(NRØW+1,LL)
      TIK = ST(NRØW+2,LL)
      TØK = ST(NRØW+3,LL)
      TØØ = ST(NRØW+4,LL)
      GØTØ 717
  715 TII = ST(NRØW+1,LL)
      TIK = TII
      TØK = TII
      TØØ = TII
C
  717 TEMP11= ALPHTH(1)+ XNUTP * ALPHPH(1)
      TEMP12= ALPHTH(2)+ XNUTP * ALPHPH(2)
      TEMP21= ALPHPH(1)+ XNUPT * ALPHTH(1)
      TEMP22= ALPHPH(2)+ XNUPT * ALPHTH(2)
      TEMP3 = 1-XNUPT*XNUTP
      TEMP4 = HI/4.0
      ETHK1=  ETHET(1)*TEMP11/TEMP3
      TEMP5 = HI**2/24.C
      ETHK2 = ETHET(2)*TEMP12/TEMP3
      TEMP61= TII+ TIK-2* TEFREE
      TEMP62= TØØ+ TØK-2* TEFREE
      TEMP71= 2.0* TII +TIK-3*TEFREE
      TEMP72= 2.0* TØØ +TØK-3*TEFREE
      EPHK1 = EPHI(1)*TEMP21/TEMP3
      EPHK2 = EPHI(2)*TEMP22/TEMP3
      GØ TØ (811,812,813,814),THICK
C
C
  811 XNTTH= ETHK1   *          TEMP4 * (TEMP61+ TEMP62)
      XNTPH= EPHK1   *          TEMP4 * (TEMP61 + TEMP62)
      XMTTH= ETHK1   *          TEMP5 * (TEMP71- TEMP72)
      XMTPH= EPHK1   *          TEMP5 * (TEMP71 - TEMP72)
      GØ TØ 714
  812 TI = (HI*(E2-E1)+2.0*E2*T)/(2.0*(E1+E2))
      TØ = (HI*(E1-E2)+2.0*E1*T)/(2.0*(E1+E2))
      TEMP8= HI/2.0
      XNTTH = ETHK1   *       TEMP8*TEMP61 + ETHK2   *       TEMP8*
     1TEMP62
      XNTPH = EPHK1  *        TEMP8*TEMP61 + EPHK2   *       TEMP8*
     1TEMP62
      XMTTH =(ETHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (ETHK2 *
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))
      XMTPH =(EPHK1 *  TEMP8 * (HI*TEMP71/3.0+ TI*TEMP61)) - (EPHK2 *
     1 TEMP8*(HI*TEMP72/3.0+TØ*TEMP62))
      GØ TØ 714
  813 TI = (E2*HØ**2-E1*HI**2+2.0*E2*HØ*T)/(2.0*(E1*HI+E2*HØ))
      TØ = (E1*HI**2-E2*HØ**2+2.0*E1*HI*T)/(2.0*(E1*HI+E2*HØ))
      XNTTH = ETHK1*0.5*(HI*TEMP61)+ETHK2*0.5*(HØ*TEMP62)
      XNTPH= EPHK1*0.5*(HI*TEMP61)+ EPHK2*0.5*(HØ*TEMP62)
      XMTTH = ETHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-ETHK2*C.5*(HØ
     1**2*TEMP72/3.+ TØ*HØ*TEMP62)
      XMTPH = EPHK1*0.5*(HI**2*TEMP71/3.0+TI*HI*TEMP61)-EPHK2*0.5*(HØ
     1**2*TEMP72/3.+ TØ*HØ*TEMP62)
      GØ TØ 714
  814 TEMP10=((-XK11*XD11)**.5)/(48.0**.5)
```

```
      TEM11 =((-XK22*XD22)**.5)/(48.0**.5)
      XNTTH =(XK11/4.0 *TEMP11)* TEMP61 + (XK11/4.0*TEMP12) * TEMP62
      XNTPH =(XK22/4.0 *TEMP21)* TEMP61 + (XK22/4.0*TEMP22) * TEMP62
      XMTTH =  TEMP10*(TEMP11*TEMP71 - TEMP12* TEMP72)
      XMTPH =  TEM11 *(TEMP21*TEMP71 - TEMP22* TEMP72)
  714 CØNTINUE
 8889 RETURN
      END
```

```
FØR,IS TEMØEG,TEMØEG
      SUBRØUTINE TEMØEG
C     THIS SUBRØUTINE CALCULATES THE GEØMETRY FØR A SHELL SEGMENT.
C     THE INPUT VARIABLES ARE . . .
C              RI(I) - - DISTANCE FRØM AXIS ØF REV. TØ PØINTS
C                        ØN SHELL MERIDIAN.
C              ZI(I) - - DISTANCE ALØNG AXIS ØF REV. TØ THE
C                        INTERSECTIØN ØF THE CØRRESPØNDING RI(I) AND
C                        THE AXIS ØF REV.
C              NRZIN - - NUMBER ØF (RI,ZI) PAIRS READ AS INPUT.
C
      CØMMØN /SNILPS/ ANG,PSI(100),RAD(100),CUR1(100),CUR2(100),
     1       DR1DP(100),ZI(14),RI(14),NRZIN
      DIMENSIØN CI(4,13),DRDZ(14),SØUT(14),S(101),RADD(100)
C
      FUN(ARG) = SQRT(1.0 + ARG**2)
C
      RADS = 3.1415926/180.0
      DATA B/-B    -/
      AMULT = 1.0
      IF (ANG.EQ.B) AMULT = -1.0
C
C     PASS SPLINE CURVE THRØUGH INPUT PØINTS ØN SHELL MERIDIAN, AND
C     CØMPUTE DR/DZ AT THESE PØINTS.
C
      CALL PLYCØ (ZI,RI,NRZIN,CI)
      NDELZ = NRZIN - 1
      DØ 60 I=1,NRZIN
      CALL PLYNE (ZI,RI,NRZIN,CI,ZI(I),FAKE1,DRDZ(I),FAKE2)
   60 CØNTINUE
C
C     CØMPUTE MERIDIØNAL ARC LENGTH TØ INTERPØLATED PØINTS BY
C     NUMERICAL INTEGRATIØN (SIMPSØNS RULE).  SINCE SIMPSØNS RULE
C     REQUIRES AN EVEN NUMBER ØF PARTITIØNS, INTERPØLATE A PØINT
C     MIDWAY BETWEEN EACH PAIR ØF PØINTS USING SUBRØUTINE  PLINE.
C
      SØUT(1) = 0.
      DØ 70 I=1,NDELZ
      DZ2=(ZI(I+1)-ZI(I))/2.0
      DZ6=DZ2/3.0
      CALL PLYNE (ZI,RI,NRZIN,CI,ZI(I)+DZ2,FAKE1,DRDZM,FAKE2)
      SØUT(I+1) = SØUT(I) + DZ6*(FUN(DRDZ(I)) + 4.0*FUN(DRDZM) +
     1            FUN(DRDZ(I+1)))
   70 CØNTINUE
C
C     USE SPLICØ TØ REPRESENT RI(I) AS A FUNCTIØN ØF SØUT(I).  THEN USE
C     SPLINE TØ INTERPØLATE RADD AND CØRRESPØNDING DERIVATIVES.  FRØM
C     THESE, CØMPUTE THE TWØ PRINCIPAL RADII ØF CURVATURE,
C       CUR1 = 1/R1
C       CUR2 = 1/R2
C
      ØLDH1 = SØUT(NRZIN)/99.0
      CALL PLYCØ (SØUT,RI,NRZIN,CI)
      DØ 110 I=1,100
      S(I) = FLØAT(I-1)*ØLDH1
      CALL PLYNE (SØUT,RI,NRZIN,CI,S(I),RAD(I),RADD(I),RADD2)
      IF (ABS(RADD(I)).GT.1.0) RADD(I)=1.0
      FACTØR = SQRT(1.0-RADD(I)**2)
      CUR1(I) = -RADD2/FACTØR
      CUR2(I) = FACTØR/RAD(I)
  110 CØNTINUE
```

```
      DØ 180 J=1,100
      CØSPSI = AMULT*RADD(J)
      PSI(J) = ARCØS(CØSPSI)
      SINPSI = -AMULT*RAD(J)*CUR2(J)
      IF (ANG.EQ.B) GØ TØ 179
      PSI(J) = 2.0*3.1415926-PSI(J)
  179 CØNTINUE
      CUR1(J) = -AMULT/CUR1(J)
      CUR2(J) = -AMULT/CUR2(J)
      IF (J.EQ.1) GØ TØ 180
      I = 1
      IF (J.EQ.2) GØ TØ 181
      I = 2
  181 IF (ANG.EQ.B) GØ TØ 190
      DR1DP(J-1) = (CUR1(J)-CUR1(J-I))/(PSI(J)-PSI(J-I))
      GØ TØ 18C
  190 DR1DP(J-1) = (CUR1(J-I)-CUR1(J))/(PSI(J-I)-PSI(J))
  180 CØNTINUE
      DR1DP(100) = DR1DP(99)
      DØ 42 J=1,100
      DR1DP(J) = DR1DP(J)*0.1
   42 CØNTINUE
      RETURN
      END
```

```
FØR,IS PLYNE,PLYNE
      SUBRØUTINE PLYNE (X,Y,M,C,XINT,YINT,DYDX,D2YDX2)
C     SUBRØUTINE FØR SPLINE FIT INTERPØLATIØN IN THE TABLE ØF VALUES
C     (X1,Y1) TØ (XM,YM), WHERE M MAY BE AS LARGE AS 100.  HERE THE
C     CØNSTANTS C(1,K),C(2,K),C(3,K) AND C(4,K) ARE ALREAD  CØMPUTED
C     AND STØRED.
C     SUBRØUTINE ALSØ CØMPUTES DY/DX AND D2Y/DX2 AT XINT.
      DIMENSIØN X(14),Y(14),C(4,13)
      IF (XINT-X(1)) 80,10,20
   10 YINT = Y(1)
      K=1
      GØ TØ 70
   20 K = 1
   30 IF (XINT-X(K+1)) 60,40,50
   40 YINT = Y(K+1)
      GØ TØ 70
   50 K = K + 1
      IF (M-K) 80,80,30
   60 YINT = (X(K+1) - XINT)*(C(1,K)*(X(K+1)-XINT)**2+C(3,K))
      YINT = YINT + (XINT-X(K))*(C(2,K)*(XINT-X(K))**2+C(4,K))
   70 DYDX=-3.C*(C(1,K)*(X(K+1)-XINT)**2-C(2,K)*(XINT-X(K))**2)
     1      -C(3,K)+C(4,K)
      D2YDX2=6.0*(C(1,K)*(X(K+1)-XINT)+C(2,K)*(XINT-X(K)))
      RETURN
   80 WRITE (6,90)
   90 FØRMAT (31H ØUT ØF RANGE FØR INTERPØLATIØN)
      RETURN
      END
```

```
FØR,IS PLYCØ,PLYCØ
      SUBRØUTINE PLYCØ (X,Y,M,C)
C     SUBRØUTINE TØ DETERMINE C(1,K),C(2,K),C(3,K) AND C(4 K).
      DIMENSIØN X(14),Y(14),A(14,3),B(14),Z(14)
      DIMENSIØN D(13),P(13),E(13),C(4,13)
      MM = M-1
      DØ 10 K=1,MM
      D(K) = X(K+1) - X(K)
      P(K) = D(K)/6.0
   10 E(K) = (Y(K+1)-Y(K))/D(K)
      DØ 20 K=2,MM
   20 B(K) = E(K) - E(K-1)
      A(1,2) = -1.0-D(1)/D(2)
      A(1,3) = D(1)/D(2)
      A(2,3) = P(2)-P(1)*A(1,3)
      A(2,2) = 2.0*(P(1)+P(2)) - P(1)*A(1,2)
      A(2,3) = A(2,3)/A(2,2)
      B(2) = B(2)/A(2,2)
      DØ 30 K=3,MM
      A(K,2) = 2.0*(P(K-1)+P(K))-P(K-1)*A(K-1,3)
      B(K) = B(K)-P(K-1)*B(K-1)
      A(K,3) = P(K)/A(K,2)
   30 B(K) = B(K)/A(K,2)
      Q = D(M-2)/D(M-1)
      A(M,1) = 1.0+Q+A(M-2,3)
      A(M,2) = -Q-A(M,1)*A(M-1,3)
      B(M) = B(M-2)-A(M,1)*B(M-1)
      Z(M) = B(M)/A(M,2)
      MN = M-2
      DØ 40 I=1,MN
      K = M-I
   40 Z(K) = B(K)-A(K,3)*Z(K+1)
      Z(1) = -A(1,2)*Z(2)-A(1,3)*Z(3)
      DØ 50 K=1,MM
      Q = 1.0/(6.0*D(K))
      C(1,K) = Z(K)*Q
      C(2,K) = Z(K+1)*Q
      C(3,K) = Y(K)/D(K)-Z(K)*P(K)
   50 C(4,K) = Y(K+1)/D(K)-Z(K+1)*P(K)
      RETURN
      END
```

SUBROUTINES ODE1 AND ODE2

Subroutine LEBEGE calls either ODE1 or ODE2, as necessary, and various geometric and trigonometric clues, as well as the predicted values of the variables for the differential equations, are passed to this subprogram via label common area LASTEQ.

The equations in ODE1 and ODE2 are identical to those in subroutines DIF1 and DIFF2 respectively, with the addition of the auxiliary equations for YAQPH, and YAQTH. Subroutines ODE1 and ODE2 perform the final integration for each segment in the structure utilizing the initial conditions previously obtained, and return these values to LEBEGE via label common area LASTEQ.

The ODE1, ODE2 flow charts are identical to the DIF1, DIFF2 flow charts, respectively

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1)
YANPT	$N_{\phi\theta}$
YAQPH	Q_{ϕ}
YAQTH	Q_{θ}
YAOPH	Ω_{ϕ}

```
FØR,IS ØDE1,ØDE1
      SUBRØUTINE ØDE1 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)                      2000010
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN                                                     2000030
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK                  2000040
      DØUBLE PRECISIØN YPRED                                             2000050
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)          2000060
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)                             2000070
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH            2000080
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)   2000090
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB  2000100
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE  2000110
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS             2000120
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),                     2000130
     1                 YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,  2000140
     2                 S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,        2000150
     3                 X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,      2000160
     4                 X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,  2000170
     5    RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,                            2000180
     6                 XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,     2000190
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),      2000200
     8                 XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,   2000210
     9                 XK11,XK12,XK21,XK22,XK33,XD11,                    2000220
     A                    M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,    2000230
     B              ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH  2000240
     C                 ,XNPHI,BETTA,ZETTA,SAVY(8),XC16                   2000250
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ         2000260
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2),(XNL(3),X3)                    2000270
      K = 0                                                              2000280
      IF (NH.EQ.0) K = 1                                                 2000290
      IF(ISTTAB.EQ.1)  GØ TØ 7786                                        2000350
      IF(ISTTAB.GE.10)GØ TØ 7786                                         2000360
C     THE FØLLØWING EQUATIØNS ARE THE -THICK- SET                        2000370
      GØ TØ (151,152,153),IGEØM                                          2000380
C   EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )              2000390
  151 YANTH      = XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(XN*YPRED(I+4)+ 2000400
     1             YPRED(I+5)*CS-YPRED(I+6)*SN)*X1RØ+K*(XNUPT*XNTPH-     2000410
     2             XNTTH)                                                2000420
      YAMTH      = XNUPT*YPRED(I+3)-(XD11-XNUPT**2*XD22)*X1RØ*(X1RØ*(XN* 2000430
     1             YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)+K*      2000440
     2             (XNUPT*XMTPH-XMTTH)                                   2000450
      YAØPH      = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ                   2000460
      YAMPT      = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*         2000470
     1             YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*    2000480
     2             (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/     2000490
     3             XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))                2000500
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))         2000510
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))                   2000520
      YANPT      = YPRED(I)+YAMPT*SN1RØ                                  2000530
      YDØT(I+4)  = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+ 2000540
     1             YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))    2000550
      YDØT(I)    = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*    2000560
     1             X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD* 2000570
     2             SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*     2000580
     3             (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+   2000590
     4             X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))            2000600
     5             -R1*X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+SN/RØ*      2000610
     6             (AØNE*YPRED(I+4)-ATWØ*YAØPH))                         2000620
      YDØT(I+5)  = R1*(YPRED(I+6)*X1R1+(1.0/(XK22-XNUTP**2*XK11))*       2000630
     1             (YPRED(I+1)-XNUTP*YANTH+K*(XNTPH-XNUTP*XNTTH)))       2000640
     2             -R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))                2000650
```

```
      EPSITH     = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH     = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1             X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1             YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2             -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3             (X1*XFZEL1+X2*XFZEL2))
     4             -R1*X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1             +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2             (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3             XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4             -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5             (X1*SAVY(1)+X2*SAVY(4)))
     6             -R1*X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)-
     7             ATWØ*YAØPH))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1             YAJPH+K*XMTHLD)
     2             +R1*X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*
     1             YAMTH-K*(XMTPH-XNUTP*XMTTH))
      GØTØ 9005
C     EQUATIØNS FØR CØNE
  152 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1CS/S)*(XN*YPRED(I+4
     1             )+YPRED(I+5)*CS-YPRED(I+6)*SN)+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(1.0/S)*X1CS*(XD11-XNUPT**2*XD22)*((1.0/S)*
     1       X1CS*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*CS)-
     2             K*(XMTTH-XNUPT*XMTPH)
      YAØPH      = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S
      YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-
     1       YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED
     2             (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)
     1             +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1             +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2             (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3             TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4             +X2*SAVY(6)))
     5             -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+TN/S*
     6             (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1             K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2             SAVY(6))
      EPSITH     = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1             YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1             (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2             XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
     3             -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1             -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2             -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3             (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4             X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     5             -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/(S*CS)*(AØNE*YPRED(I+4)
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     6              -ATWØ*YAØPH))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1              *K
     2              +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH-
     1              K*(XMTPH-XNUTP*XMTTH))
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
  153 YANTH=XNUPT*YPRED(I+1)+(XK11-XNUPT**2*XK22)*(X1RØ*(XN*YPRED(I+4)-
     1              YPRED(I+6)))+K*(XNUPT*XNTPH-XNTTH)
      YAMTH=XNUPT*YPRED(I+3)-(X1RØ*(XD11-XNUPT**2*XD22))*(X1RØ*(XN*YPRED
     1              (I+4)-XNSQ*YPRED(I+6)))+K*(XNUPT*XMTPH-XMTTH)
      YAØPH     = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
     1              YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
     2              SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1              -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
     1              +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1              -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2              X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3              (X1*SAVY(3)+X2*SAVY(6)))
     4              -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+1.0/RØ*
     5              (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = (1.0/(XK22-XNUTP**2*XK11))*(YPRED(I+1)-XNUTP*YANTH+
     1              K*(XNTPH-XNUTP*XNTTH))-YPRED(I+7)*(X1*SAVY(3)+X2*
     2              SAVY(6))
      EPSITH    = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1              EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2              X2*XFZEL2)
     3              -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1              XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2              YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3              (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     4              -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)
     5              -ATWØ*YAØPH))
      YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
     1              +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = (1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I+3)+XNUTP*YAMTH+
     1              K*(XNUTP*XMTTH-XMTPH))
      GØ TØ 9005
 7786 GØ TØ (4771,4772,4773),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -ST10- SET
C     EQUATIØNS FØR SHELLS ØF REVØLUTIØN  ( PHI  CØØRDINATE )
 4771 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1              (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(X1RØ*XK11-
     1              XK12*XK21*X1RØ*(1.0/
     2       (XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+
     3      6)*SN)-(XC11+XK12*XC22*XD21/XD22*(1.0/(XK22+XC22**2/XD22)))*
     4       (X1RØ**2*(XN*YPRED(I+4)*SN-XN**2*YPRED(I+6))+YPRED(I+7)*CS*
     5       X1RØ)
      YAMTH     = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
     1              -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
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     1           K*XMTPH)+(XC11*
     2     X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED(
     3     I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*XD21/(
     4     XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED
     5     (I+6))+YPRED(I+7)*CS*X1RØ)
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT     = (-1.0/((RØ/XD33)+(SNSQ*X1RØ/XK33)))*(-2.0*XN*
     1           YPRED(I+7)+YPRED(I+4)*(CS1R1-CN1RØ)+XN*YPRED(I+5)*
     2           (SN1RØ+X1R1)+2.0*XN*YPRED(I+6)*CS1RØ+YPRED(I)*SN/
     3           XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1           -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*SN1RØ
      YDØT(I+4) = R1*(YPRED(I+4)*CS1RØ+XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+
     1           YAMPT*SN1RØ/XK33)+R1*YAØPH*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I)   = R1*(-2.C*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
     1           X1RØSQ-YAMPT*CS1RØ*(X1R1-SN1RØ))-R1*K*(XFTHLD+XMPHLD*
     2           SN1RØ)-(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YAØPH*
     3           (X1*XFZEL1+X2*XFZEL2))-R1*SN1RØ*(YAØPH*(X1*SAVY(1)+
     4           X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))
     5           -R1*X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH*SN/RØ*
     6           (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = R1*(YPRED(I+6)*X1R1-YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
     1           +(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+(XC22/
     1           XD22)*(YPRED(I+3)+K*XMTPH)-XK21*X1RØ*(XN*
     2          YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22
     3          )*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)
     4          *CS*X1RØ)))
      EPSITH    = X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)
      EPSIPH    = X1R1*(YDØT(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+
     1           X2*SAVY(6))
      YDØT(I+1) = R1*(CS1RØ*(YANTH-YPRED(I+1))-XN*X1RØ*(YPRED(I)+
     1           YAMPT*(SN*X1RØ+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD
     2           -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)*
     3           (X1*XFZEL1+X2*XFZEL2))
     4           -R1*X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = R1*(-YPRED(I+2)*CS1RØ-YANTH*SN1RØ-YPRED(I+1)*X1R1
     1           +XNSQ*YAMTH*X1RØSQ-2.0*XN*YAMPT*CS*X1RØSQ)+R1*K*
     2           (XN*XMPHLD*X1RØ-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*
     3           XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))
     4           -R1*X1RØ*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YAØPH*
     5           (X1*SAVY(1)+X2*SAVY(4)))
     6           -R1*X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)-
     7           ATWØ*YAØPH))
      YDØT(I+3) = R1*(YAMTH*CS1RØ-YPRED(I+3)*CS1RØ-2.0*XN*YAMPT*X1RØ+
     1           YAJPH+K*XMTHLD)
     2           +R1*X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)
      YDØT(I+7) = R1*((-XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-
     1           (XK21/
     1          RØ)*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN))
     2          +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*
     3          XD21/(XC22**2+XK22*XD22))*(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     4          *YPRED(I+6))+YPRED(I+7)*CS*X1RØ))
      GØ TØ 9005
C     EQUATIØNS FØR CØNE
 4772 YANTH     = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+
     1           (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(1.0/(CS*S))
     1           *(XK11-XK12*XK21*(
     2     1.0/(XK22+XC22**2/XD22)))*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3     YPRED(I+6)*SN)-(XC11+(XK12*XD21*XC22/XD22)*(1.0/(XK22+XC22*
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    4        *2/XD22)))*((1.0/(S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED  2002490
    5        (I+6))+YPRED(I+7)/S)                                         2002500
     YAMTH      = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)   2002510
    1             -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+   2002520
    1             K*XMTPH)+(XC11/                                         2002530
    2        (S*CS)+XD12*XK21/(S*CS))*(XC22/(XC22**2+XK22*XD22))*(XN*     2002540
    3        YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+(XD11-XD12*XK22*     2002550
    4        XD21/(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*   2002560
    5        SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S)                            2002570
     YAØPH      = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S                   2002580
     YAMPT=(-1.0/((S*CS/XD33)+(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I+7)-     2002590
    1       YPRED(I+4)*SN/S+XN*YPRED(I+5)*TN/S+2.0*XN*YPRED(I+6)/S+YPRED  2002600
    2             (I)*SN/XK33+SN*YAØPH*(X1*SAVY(3)+X2*SAVY(6)))           2002610
     YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))           2002620
    1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))                     2002630
     YANPT      = YPRED(I)+YAMPT*TAN/S                                    2002640
     YDØT(I+4)=(1.0/S)*(YPRED(I+4)+XN*YPRED(I+5)*X1CS+YAMPT*TN/XK33)      2002650
    1             +YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*SAVY(6))            2002660
     YDØT(I)   =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2  2002670
    1             +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*     2002680
    2             (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-     2002690
    3             TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)  2002700
    4             +X2*SAVY(6)))                                           2002710
    5             -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+TN/S*            2002720
    6             (AØNE*YPRED(I+4)-ATWØ*YAØPH))                           2002730
     YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2   2002740
    1             /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)     2002750
    1             +K*XMTPH)-(XK21/(S*CS))*(XN*YPRED(I+4)+YPRED(           2002760
    2        I+5)*CS-YPRED(I+6)*SN)-(XC22*XD21/XD22)*((1.0/(S**2*CS**     2002770
    3        2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)/S))        2002780
     EPSITH     = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*           2002790
    1             YPRED(I+6))                                             2002800
     EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))            2002810
     YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/     2002820
    1             (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*    2002830
    2             XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)                2002840
    3             -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))            2002850
     YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)        2002860
    1             -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)     2002870
    2             -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*      2002880
    3             (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+     2002890
    4             X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))              2002900
    5             -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/(S*CS)*(AØNE*YPRED(I+4)  2002910
    6             -ATWØ*YAØPH))                                           2002920
     YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD     2002930
    1             *K                                                      2002940
    2             +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))           2002950
     YDØT(I+6)=YPRED(I+7)                                                 2002960
     YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*    2002970
    1             (XN*                                                    2002980
    1        YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)/(S*CS))              2002990
    2        +(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+K*XMTPH)-(XK22*      2003000
    1        XD21                                                         2003010
    3        /(XC22**2+XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I+4)*SN     2003020
    4        -XN**2*YPRED(I+6))+YPRED(I+7)/S)                             2003030
     GØ TØ 9005                                                           2003040
C    EQUATIØNS FØR CYLINDER                                               2003050
4773 YANTH      = XK12*(1.0/(XK22+XC22**2/XD22))*(YPRED(I+1)+K*XNTPH+     2003060
    1             (XC22/XD22)*(YPRED(I+3)+K*XMTPH))-K*XNTTH+(XIRØ*(XK11-  2003070
    1             XK12*XK21*(1.0/(                                        2003080
    2        XK22+XC22**2/XD22))))*(XN*YPRED(I+4)-YPRED(I+6))-(XC11+(     2003090
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3        XK12*XC22*XD21/XD22)*(1.0/(XK22+XC22**2/XD22)))*(X1RØ**2*(
4        XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
 YAMTH      = -XD12*(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH)
1             -K*XMTTH+XD12*(XK22/(XC22**2+XK22*XD22))*(YPRED(I+3)+
1             K*XMTPH)+(XC11*
2         X1RØ+XD12*XK21*X1RØ*(XC22/(XC22**2+XK22*XD22)))*(XN*YPRED
3         (I+4)-YPRED(I+6))+(XD11-XD12*XK22*XD21/(XC22**2+XK22*XD22)
4         )*(X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
 YAØPH      = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
 YAMPT=(-1.0/((RØ/XD33)+(X1RØ/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RØ*
1             YPRED(I+5)+YPRED(I)/XK33+YAØPH*(X1*SAVY(3)+X2*
2             SAVY(6)))
 YAJPH      = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
1            -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
 YANPT      = YPRED(I)+YAMPT*X1RØ
 YDØT(I+4)=XN*YPRED(I+5)*X1RØ+YPRED(I)/XK33+YAMPT*X1RØ/XK33
1             +YAØPH*(X1*SAVY(3)+X2*SAVY(6))
 YDØT(I)    = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
1             -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
2             X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
3             (X1*SAVY(3)+X2*SAVY(6)))
4             -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+1.0/RØ*
5             (AØNE*YPRED(I+4)-ATWØ*YAØPH))
 YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(1.0/(XK22+XC22**2
1             /XD22))*(YPRED(I+1)+K*XNTPH+(XC22/XD22)*(YPRED(I+3)
1             +K*XMTPH)-(XK21*X1RØ)*(XN*YPRED(I+4)-YPRED
2        (I+6))-(XC22*XD21/XD22)*(X1RØSQ*(XN*(YPRED(I+4)-XN*YPRE
3             D(I+6)))))
 EPSITH     = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
 EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
 YDØT(I+1) = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
1             EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
2             X2*XFZEL2)
3             -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
 YDØT(I+2) = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
1             XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
2             YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
3             (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
4             -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)
5             -ATWØ*YAØPH))
 YDØT(I+3) = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
1             +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
 YDØT(I+6)=YPRED(I+7)
 YDØT(I+7) = -(XC22/(XC22**2+XK22*XD22))*(YPRED(I+1)+K*XNTPH-XK21*
1             X1RØ*(
1           XN*YPRED(I+4)-YPRED(I+6)))+(XK22/(XC22**2+XK22*XD22))*(
2             YPRED(I+3)+K*XMTPH)-(XK22*XD21/(XC22**2+XK22*XD22))*(
3           X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6)))
9005 IY =8*(M-1)+1
 YASAVE(IY) = YANTH
 YASAVE(IY+1)=YAMTH
 YASAVE(IY+2)=YAMPT
 YASAVE(IY+3)=YANPT
 YASAVE(IY+4)=YAØPH
 YASAVE(IY+7) = YAJPH
 RETURN
  END
```

```
FØR,IS ØDE2,ØDE2
      SUBRØUTINE ØDE2 (XFPHL1,XFZEL1,XFPHL2,XFZEL2)
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN1,XN
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      DØUBLE PRECISIØN YPRED
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(3C),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      CØMMØN /LASTEQ/ YPRED(16),YDØT(16),YASAVE(16),
     1                 YANTH,YAMTH,YAMPT,YANPT,YAØPH,YAQPH,YAQTH,YAJPH,
     2                 S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,
     3                 X1RØ,X1RØSQ,X1SNRØ,X1CSRØ,CN1RØ,SN1RØ,CS1RØ,
     4                 X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RØ,BESQ,
     5    RØSQ,XNSQ,BETA,R1,R2,S1,R1DØT,R1SQ,
     6                 XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,
     7  XMTHLD,XMPHLD,ETHET(2),EPHI(2),XGPT(2),ALPHTH(2),ALPHPH(2),
     8                 XNUTP,XNUPT,XC11,XC22,XC15,XD33,XD22,XD21,XD12,
     9                 XK11,XK12,XK21,XK22,XK33,XD11,
     A                    M,I,SITIN,SITØUT,SIPIN,SIPØUT,TPTIN,TPTØUT,
     B              ZBRIN,ZBRØUT,SCRIPA,SCRIPI,SIFIN,SIFØUT,TZEPH,TZETH
     C                ,XNPHI,BETTA,ZETTA,SAVY(8),XC16
      CØMMØN /PLS/ ØMEGA,IWØRD,XMERD,XPRES,XMØNT,AZERØ,AØNE,ATWØ
      EQUIVALENCE (XNL(1),X1),(XNL(2),X2),(XNL(3),X3)
      K = 0
      IF (NH.EQ.0) K = 1
      GØ TØ (7341,7342,7343),IGEØM
C     THE FØLLØWING EQUATIØNS ARE THE -RWAF- SET
C     EQUATIØNS FØR SHELLS ØF REVØLUTIØN ( PHI CØØRDINATE )
 7341 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     3 YPRED(I+6)*SN)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ
     5 *YPRED(I+6))+X1RØ*YPRED(I+7)*CS)*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22*XC22)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+(X1RØSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+
     3 X1RØ*YPRED(I+7)*CS)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-
     3 XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)+YPRED(I+5)*CS-
     5 YPRED(I+6)*SN)*(XC11+(XC12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))
      YAØPH     = XN*YPRED(I+6)*X1RØ-YPRED(I+4)*SN1RØ
      YAMPT = (1.0/(XC16*SN*X1RØ-XK33-SN*X1RØ*(XD33*SN/(      RØ)-XC16)))
     1        *((XK33*XD33-XC16**2)*X1RØ*(-2.0*XN*YPRED(I+7)+YPRED(I+4)*
     2        (CS*X1R1-CN1RØ)+XN*YPRED(I+5)*(X1R1+SN1RØ)+2.0*XN*YPRED
     3        (I+6)*CS*X1RØ)+YAØPH*SN*(X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*
     4        (XD33*SN*X1RØ-XC16))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
     1          -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT     = YPRED(I)+YAMPT*SN1RØ
      YDØT(I+4) = R1*(YPRED(I+4)*CS*X1RØ+YAØPH*(X1*SAVY(3)+X2*SAVY(6))
     1          +XN*YPRED(I+5)*X1RØ+(1.0/(XK33-
     1          XC16**2/XD33))*(YPRED(I)+YAMPT*(SN*X1RØ-XC16/XD33)))
      YDØT(I)   = R1*(-2.0*YPRED(I)*CS1RØ+XN*YANTH*X1RØ-XN*YAMTH*SN*
```

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     1              X1R0SQ-YAMPT*CS1R0*(X1R1-SN1R0))-R1*K*(XFTHLD+XMPHLD*  2100660
     2              SN1R0)-(YD0T(I+4)*(X1*XFPHL1+X2*XFPHL2)+R1*YA0PH*      2100670
     3              (X1*XFZEL1+X2*XFZEL2))-R1*SN1R0*(YA0PH*(X1*SAVY(1)+    2100680
     4              X2*SAVY(4))-YANPT*(X1*SAVY(3)+X2*SAVY(6)))             2100690
     5              -R1*X3*0MEGA*(AZER0*YPRED(I+4)-A0NE*YA0PH+SN/R0*       2100700
     6              (A0NE*YPRED(I+4)-ATW0*YA0PH))                          2100710
      YD0T(I+5) = YPRED(I+6)-R1*YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+R1*     2100720
     1              (XD22*(YPRED(I+1)+K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-  2100730
     2              X1R0*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*      2100740
     3              (XK12*XD22+XC15*XC22)-(X1R0SQ*(XN*YPRED(I+4)-XNSQ*     2100750
     4              YPRED(I+6))+X1R0*YPRED(I+7)*CS)*(XC22*XD12-XC15*XD22)) 2100760
     5              /(XK22*XD22+XC22**2)                                   2100770
      EPSITH    = X1R0*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)         2100780
      EPSIPH    = X1R1*(YD0T(I+5)-YPRED(I+6))+YPRED(I+7)*(X1*SAVY(3)+      2100790
     1              X2*SAVY(6))                                            2100800
      YD0T(I+1) = R1*(CS1R0*(YANTH-YPRED(I+1))-XN*X1R0*(YPRED(I)+          2100810
     1              YAMPT*(SN*X1R0+X1R1))+YPRED(I+2)*X1R1)-R1*K*XFPHLD     2100820
     2              -R1*((EPSITH+EPSIPH)*(X1*XFPHL1+X2*XFPHL2)-YPRED(I+7)* 2100830
     3              (X1*XFZEL1+X2*XFZEL2))                                 2100840
     4              -R1*X3*0MEGA*(AZER0*YPRED(I+5)+A0NE*YPRED(I+7))        2100850
      YD0T(I+2) = R1*(-YPRED(I+2)*CS1R0-YANTH*SN1R0-YPRED(I+1)*X1R1        2100860
     1              +XNSQ*YAMTH*X1R0SQ-2.0*XN*YAMPT*CS*X1R0SQ)+R1*K*       2100870
     2              (XN*XMPHLD*X1R0-XFZELD)-R1*((EPSITH+EPSIPH)*(X1*       2100880
     3              XFZEL1+X2*XFZEL2)+YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2))    2100890
     4              -R1*X1R0*XN*(YANPT*(X1*SAVY(3)+X2*SAVY(6))-YA0PH*      2100900
     5              (X1*SAVY(1)+X2*SAVY(4)))                               2100910
     6              -R1*X3*0MEGA*(AZER0*YPRED(I+6)-XN/R0*(A0NE*YPRED(I+4)- 2100920
     7              ATW0*YA0PH))                                           2100930
      YD0T(I+3) = R1*(YAMTH*CS1R0-YPRED(I+3)*CS1R0-2.0*XN*YAMPT*X1R0+      2100940
     1              YAJPH+K*XMTHLD)                                        2100950
     2              +R1*X3*(0MEGA*(A0NE*YPRED(I+5)+ATW0*YPRED(I+7)))       2100960
      YD0T(I+6) = R1*(YPRED(I+7)-YPRED(I+5)*X1R1)                          2100970
      YD0T(I+7) = R1*(XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*        2100980
     1              XNTPH)+X1R0                                            2100990
     1*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)*(XK12*XC22-XK22*XC15)   2101000
     2-(X1R0SQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+X1R0*YPRED(I+7)*CS)*     2101010
     3(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)                           2101020
      G0 T0 9005                                                           2101030
C     EQUATI0NS F0R C0NE                                                   2101040
 7342 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+   2101050
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/        2101060
     2 (XC22*XC22+XK22*XD22)+(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)       2101070
     3 *SN)/(S*CS)*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*        2101080
     4 XD22)/(XK22*XD22+XC22*XC22))+((XN*YPRED(I+4)*SN-XNSQ*               2101090
     5 YPRED(I+6))/(S*S*CSSQ)+YPRED(I+7)/S)*(-XC11+(XC15*XC15*XC22+        2101100
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))   2101110
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+   2101120
     1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+     2101130
     2 XC22**2)-K*XMTTH+(1.0/(S*S*CSSQ)*(-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*   2101140
     3 SN)+YPRED(I+7)/S)*(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*   2101150
     4 XD22))/(XC22*XC22+XK22*XD22))+1.0/(S*CS)*(XN*YPRED(I+4)+            2101160
     5 YPRED(I+5)*CS-                                                      2101170
     5 YPRED(I+6)*SN)*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+     2101180
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))                                  2101190
      YA0PH     = XN*YPRED(I+6)*X1CS/S-YPRED(I+4)*TAN/S                    2101200
      YAMPT =((XC16*TAN/S-XK33-(TAN/S)*(XD33*TAN/S-XC16))**(-1))*((XK33*   2101210
     1        XC33-XC16**2)*(1.0/(S*CS))*(-2.0*XN*YPRED(I+7)-YPRED(I+4)*   2101220
     2         SN/S+XN*YPRED(I+5)*TAN/S+2.0*XN*YPRED(I+6)/S)+YA0PH*SN*     2101230
     3         (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*TAN/S-XC16))         2101240
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))            2101250
     1              -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))                    2101260
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```
      YANPT     = YPRED(I)+YAMPT*TAN/S
      YDØT(I+4) = YPRED(I+4)/S+YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*
     1            YPRED(I+5)/(S*CS)+(1.0/(XK33-XC16**2/
     1             XD33))*(YPRED(I)+YAMPT*(TAN/S-XC16/XD33))
      YDØT(I)  =-2.0*YPRED(I)/S+XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2
     1            +YAMPT*TAN/S**2-K*(XFTHLD+XMPHLD*TAN/S)-(YDØT(I+4)*
     2            (X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+X2*XFZEL2))-
     3            TAN/S*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*(X1*SAVY(3)
     4            +X2*SAVY(6)))
     5            -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+TN/S*
     6            (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5) = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
     1            +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-(XK12*
     1          XD22+XC15*XC22)*(1.0/(S*CS)*(XN*YPRED(I+4)+YPRED(I+5)*
     2          CS-YPRED(I+6)*SN))-(XC22*XD12-XC15*XD22)*((-XNSQ*
     3          YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+YPRED(I+7)/S))
     4          /(XK22*XD22+XC22*XC22)
      EPSITH    = (1.0/(S*CS))*(XN*YPRED(I+4)+CS*YPRED(I+5)-SN*
     1            YPRED(I+6))
      EPSIPH    = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/
     1            (S**2*CS**2)-K*XFPHLD-(EPSITH+EPSIPH)*(X1*XFPHL1+X2*
     2            XFPHL2)+YPRED(I+7)*(X1*XFZEL1+X2*XFZEL2)
     3            -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2) = -YPRED(I+2)/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)
     1            -2.0*XN*YAMPT/(S**2*CS)+K*(XN*XMPHLD*X1CS/S-XFZELD)
     2            -(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-YPRED(I+7)*
     3            (X1*XFPHL1+X2*XFPHL2)-X1CS/S*XN*(YANPT*(X1*SAVY(3)+
     4            X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     5            -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/(S*CS)*(AØNE*YPRED(I+4)
     6            -ATWØ*YAØPH))
      YDØT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD
     1            *K
     2            +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7) = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)+
     1          (XK12*XC22-XK22*XC15)*(1.0/(S*CS)*(XN*YPRED(I+4)+
     2          YPRED(I+5)*CS-YPRED(I+6)*SN))-(XC15*XC22+XK22*XD12)*
     3          ((-XNSQ*YPRED(I+6)+XN*YPRED(I+4)*SN)/(S*S*CSSQ)+
     4          YPRED(I+7)/S))/(XK22*XD22+XC22*XC22)
      GØ TØ 9005
C     EQUATIØNS FØR CYLINDER
 7343 YANTH     = (YPRED(I+1)+K*XNTPH)*(XC15*XC22+XD22*XK12)/(XK22*XD22+
     1 XC22**2)-K*XNTTH+(XK12*XC22-XK22*XC15)*(YPRED(I+3)+K*XMTPH)/
     2 (XC22*XC22+XK22*XD22)+X1RØ*(XN*YPRED(I+4)-
     3 YPRED(I+6))*(XK11+(XC15*(XC15*XK22-2.0*XK12*XC22)-XK12*XK12*
     4 XD22)/(XK22*XD22+XC22*XC22))+(X1RØSQ*(XN*YPRED(I+4)-XNSQ
     5 *YPRED(I+6)))*(-XC11+(XC15*XC15*XC22+
     6 XC15*(XK12*XD22+XK22*XD12)-XK12*XD12*XC22)/(XK22*XD22+XC22*XC22))
      YAMTH     = (YPRED(I+3)+K*XMTPH)*(XC15*XC22+XK22*XD12)/(XK22*XD22+
     1 XC22**2)+(YPRED(I+1)+K*XNTPH)*(XD22*XC15-XD12*XC22)/(XD22*XK22+
     2 XC22**2)-K*XMTTH+X1RØSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))
     3 *(XD11-(XD12*XD12*XK22+XC15*(2.0*XC22*XD12-XC15*
     4 XD22))/(XC22*XC22+XK22*XD22))+X1RØ*(XN*YPRED(I+4)-
     5 YPRED(I+6))*(XC11+(XD12*XC22*XK12-XC15*(XC15*XC22+XD12*XK22+
     6 XD22*XK12))/(XC22*XC22+XK22*XD22))
      YAØPH     = X1RØ*(XN*YPRED(I+6)-YPRED(I+4))
      YAMPT=(1/(XC16*X1RØ-XK33-X1RØ*(XD33*X1RØ-XC16)))*((XK33*XD33-XC16
     1         **2)*X1RØ*(-2.0*XN*YPRED(I+7)+XN*X1RØ*YPRED(I+5))+YAØPH*
     2         (X1*SAVY(3)+X2*SAVY(6))+YPRED(I)*(XD33*X1RØ-XC16))
      YAJPH     = YPRED(I+2)-YPRED(I+1)*(X1*SAVY(3)+X2*SAVY(6))
```

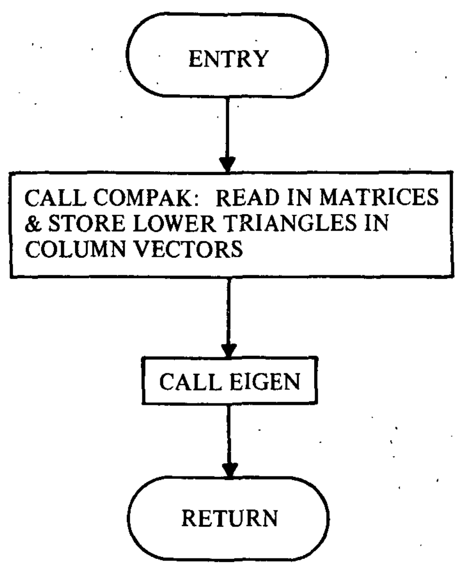
```
     1             -YPRED(I+7)*(X1*SAVY(2)+X2*SAVY(5))
      YANPT      = YPRED(I)+YAMPT*X1RØ
      YDØT(I+4)  = (YAØPH*(X1*SAVY(3)+X2*SAVY(6))+XN*YPRED(I+5)/RØ)+
     1             (1.0/(XK33-XC16**2/XD33))*(YPRED(I)+
     1           YAMPT*(X1RØ-XC16/XD33))
      YDØT(I)    = XN*YANTH*X1RØ-XN*YAMTH*X1RØSQ-K*(XFTHLD+XMPHLD*X1RØ)
     1             -(YDØT(I+4)*(X1*XFPHL1+X2*XFPHL2)+YAØPH*(X1*XFZEL1+
     2             X2*XFZEL2))-X1RØ*(YAØPH*(X1*SAVY(1)+X2*SAVY(4))-YANPT*
     3             (X1*SAVY(3)+X2*SAVY(6)))
     4             -X3*ØMEGA*(AZERØ*YPRED(I+4)-AØNE*YAØPH+1.0/RØ*
     5             (AØNE*YPRED(I+4)-ATWØ*YAØPH))
      YDØT(I+5)  = -YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))+(XD22*(YPRED(I+1)
     1             +K*XNTPH)+XC22*(YPRED(I+3)+K*XMTPH)-X1RØ*
     1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XD22+XC15*XC22)-X1RØSQ*(XN*YPRED
     2(I+4)-XNSQ*YPRED(I+6))*(XC22*XD12-XC15*XD22))/(XK22*XD22+XC22**2)
      EPSITH     = X1RØ*(XN*YPRED(I+4)-YPRED(I+6))
      EPSIPH     = YDØT(I+5)+YPRED(I+7)*(X1*SAVY(3)+X2*SAVY(6))
      YDØT(I+1)  = -XN*X1RØ*YPRED(I)-XN*YAMPT*X1RØSQ-K*XFPHLD-(EPSITH+
     1             EPSIPH)*(X1*XFPHL1+X2*XFPHL2)+YPRED(I+7)*(X1*XFZEL1+
     2             X2*XFZEL2)
     3             -X3*ØMEGA*(AZERØ*YPRED(I+5)+AØNE*YPRED(I+7))
      YDØT(I+2)  = -YANTH*X1RØ+XNSQ*YAMTH*X1RØSQ+K*(XN*XMPHLD*X1RØ-
     1             XFZELD)-(EPSITH+EPSIPH)*(X1*XFZEL1+X2*XFZEL2)-
     2             YPRED(I+7)*(X1*XFPHL1+X2*XFPHL2)-X1RØ*XN*(YANPT*
     3             (X1*SAVY(3)+X2*SAVY(6))-YAØPH*(X1*SAVY(1)+X2*SAVY(4)))
     4             -X3*ØMEGA*(AZERØ*YPRED(I+6)-XN/RØ*(AØNE*YPRED(I+4)
     5             -ATWØ*YAØPH))
      YDØT(I+3)  = -2.0*XN*YAMPT*X1RØ+YAJPH+K*XMTHLD
     1             +X3*(ØMEGA*(AØNE*YPRED(I+5)+ATWØ*YPRED(I+7)))
      YDØT(I+6)=YPRED(I+7)
      YDØT(I+7)  = (XK22*(YPRED(I+3)+K*XMTPH)-XC22*(YPRED(I+1)+K*XNTPH)
     1             +X1RØ*
     1(XN*YPRED(I+4)-YPRED(I+6))*(XK12*XC22-XK22*XC15)-X1RØSQ*(XN*YPRED
     2(I+4)-XNSQ*YPRED(I+6))*(XC15*XC22+XK22*XD12))/(XC22**2+XK22*XD22)
 9005 IY =8*(M-1)+1
      YASAVE(IY) = YANTH
      YASAVE(IY+1)=YAMTH
      YASAVE(IY+2)=YAMPT
      YASAVE(IY+3)=YANPT
      YASAVE(IY+4)=YAØPH
      YASAVE(IY+7) = YAJPH
      RETURN
       END
```

SUBROUTINE EIGVAL

This is the controlling routine for the program eigenvalue calculation loop. The necessary matrices for the calculations are passed to COMPAK, and thence to routine EIGEN. The controlling routine EIGVAL will provide intermediate matrix print as desired.

<u>Subroutine COMPAK</u>: This routine reads rows of a two-dimensional array from a storage unit into core and then stores them into a column vector.

EIGVAL


ENTRY
CALL COMPAK: READ IN MATRICES & STORE LOWER TRIANGLES IN COLUMN VECTORS
CALL EIGEN
RETURN

```
FØR,IS EIGVAL,EIGVAL
      SUBRØUTINE EIGVAL (CØNV,EIG,N,IBEGIN,QVEC,NPAS)
      DIMENSIØN A(8400),B(8300),Q(1024),QVEC(128,1)
      CØMMØN /ARING/ NRING(28),AMAT(30,4),ISTART,NUMVEC,MSEIG
      NCHK = 0
      PØW = 1.0
    1 CØNTINUE
      REWIND 4
      REWIND 11
      CALL CØMPAK (4,N,A)
      CALL CØMPAK (11,N,B)
      INDEX = (N*N+N)/2
      IF (IBEGIN.EQ.0.ØR.NCHK.NE.0) GØ TØ 50
      M = 1
      WRITE(6,21)
   21 FØRMAT(1H1,53X,-DYNAMIC STIFFNESS MATRIX-/)
      DØ 20 J=1,N
      K = M+J-1
      WRITE(6,22) J,(A(I),I=M,K)
   22 FØRMAT(I5,1P8E15.6/(5X,1P8E15.6))
   20 M = K+1
      M = 1
      WRITE(6,31)
   31 FØRMAT(1H1,47X,-ELASTIC ØR PRESTRESS STIFFNESS MATRIX-/)
      DØ 30 J=1,N
      K = M+J-1
      WRITE(6,22) J,(B(I),I=M,K)
   30 M = K+1
   50 CØNTINUE
      DØ 10 J=1,INDEX
   10 A(J) = -(A(J)-B(J))
      IF (MSEIG.EQ.0) GØ TØ 70
      RAT = 0.0
      M = 1
      DØ 40 J=1,N
      K = M+J-1
      RAT1 = ABS(B(K)/A(K))
      IF (RAT1.GT.RAT) RAT = RAT1
   40 M = K+1
      ALAMDA = 1.E-5*RAT/PØW
      DØ 60 J=1,INDEX
   60 B(J) = B(J)+ALAMDA*A(J)
   70 CØNTINUE
      CALL EIGEN (N,A,B,CØNV,Q,EIG,QVEC,NPAS,NCHK,ALAMDA,PØW)
      IF (NCHK.NE.0) GØ TØ 1
      RETURN
      END
```

```
FØR,IS CØMPAK,CØMPAK
      SUBRØUTINE CØMPAK (NTAPE,IRØW,C)
      DIMENSIØN C(1),X(128)
      M = 1
      DØ 10 J=1,IRØW
      READ(NTAPE) (X(I),I=1,IRØW)
      DØ 20 L=1,J
      C(M) = X(L)
   20 M = M+1
   10 CØNTINUE
      RETURN
      END
```

SUBROUTINE EIGEN

EIGEN is the main eigenvalue and eigenvector calculation routine. Printout of the eigenvalues and appropriate eigenvectors is provided by this routine. First EIGEN prepares the matrices for eigenvalue extraction, calling FUTILE, DAGGER, and SWITCH. Then the matrices are passed to SYMEIG, which obtains the eigenvalues and specified vectors using the Householder technique.

Subroutine DAGGER: This routine performs the reduction of the two matrix eigenvalue problem to a standard eigenvalue problem.

Subroutine SYMEIG (Alternate entry point SYMVEC): This routine obtains the eigenvalues and vectors of a real, symmetric, matrix.

Subroutine TFORM: This routine performs the Householder similarity reduction of a real, symmetric matrix to tri-diagonal form.

Subroutine STURM: Performs the Sturm-sequence calculations of eigenvalues of a real, symmetric, tri-diagonal matrix.

Subroutine PREP (alternate entry point DET): Determines the number of roots greater or equal to a stipulated value.

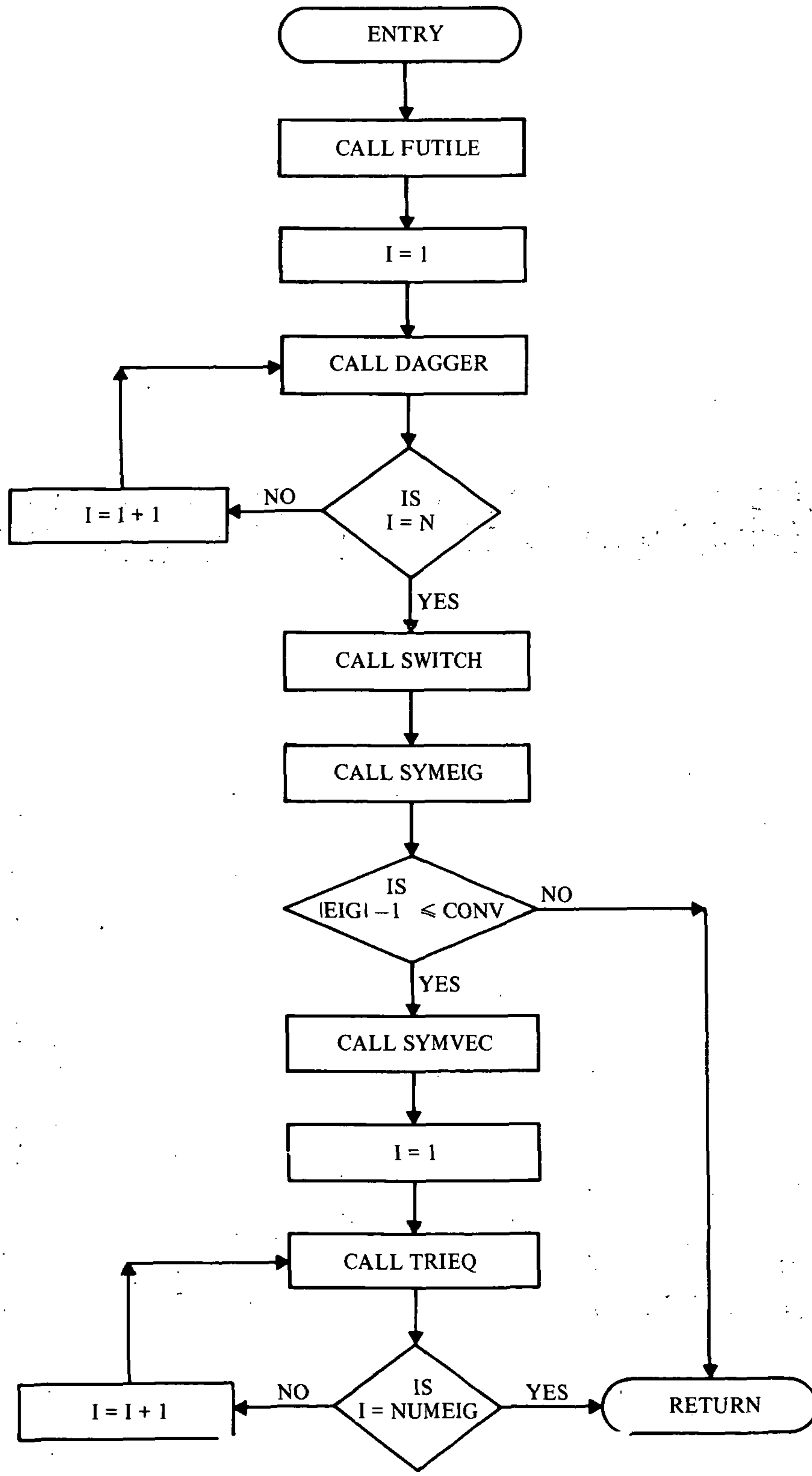
Subroutine QSVEC (alternate entry point QWIEL): Obtains eigenvectors of a tri-diagonal matrix and back transforms them to eigenvectors of the original real, symmetric matrix.

Subroutine RANDOM: Random number generator. This subroutine is an MSFC system subroutine and the listing is not included here. Most any random number generator may be substituted or the argument may be set to zero.

Subroutine ANDD: This routine "ands" or "ors" the corresponding bits of two given variables with each other.

Subroutine DOTPRO: Performs inner product accumulation using labeled common area INFO.

EIGEN



ENTRY
CALL FUTILE
I = 1
CALL DAGGER
IS
I = N
NO
I = I + 1
YES
CALL SWITCH
CALL SYMEIG
IS
|EIG| − 1 ≤ CONV
NO
YES
CALL SYMVEC
I = 1
CALL TRIEQ
IS
I = NUMEIG
NO
I = I + 1
YES
RETURN

```
FØR,IS EIGEN,EIGEN
      SUBRØUTINE EIGEN (N,A,B,CØNV,Q,EIG,QVEC,NPAS,NCHK,ALAMDA,PØW)
C
C        (A)(X)=(LAMBDA)(B)(X)
C
      DIMENSIØN A(1),Q(1),B(1)
      DIMENSIØN C(128),QVEC(128,1)
      CØMMØN /ARING/ NRING(28),AMAT(30,4),ISTART,NUMVEC,MSEIG
      CØMMØN /WINTER/INDIC8
      CØMMØN /BØND/M,L
      REWIND 4
      INDIC8=-1
      M=N
      L=1
      TØL = 0.1E-7
      NUMEIG = N
      INDEX=(N*N+N)/2+1
      INDEX1=INDEX-1
      NIX = 0
C
C   FØRM CHØLESKY DECØMPØSITIØN ØF B MATRIX
C
      CALL FUTILE (B,N,NIX)
      IF(NIX)2,3,4
    2 WRITE(6,41)
   41 FØRMAT(- B IS NØT PØSITIVE DEFINITE-)
      RETURN
    4 WRITE(6,42)
   42 FØRMAT(- ØVERFLØW IN FUTILE-)
C
C     L-MATRIX STØRED IN B
C
C
C   FØRM A-MATRIX CØLUMN INVERSES.- STØRE IN Q
C
    3 IØFF=1
      DØ 10 I=1,N
      J2 = IØFF+I-1
      K = 1
      DØ 1 J=IØFF,J2
      Q(K) = B(J)
    1 K = K+1
      WRITE(4) (Q(J),J=1,I)
      IØFF = IØFF+I
      X=-Q(I)
      Q(I)=-1.
      DØ 20 J=1,I
   20 Q(J)=Q(J)/X
   10 CALL DAGGER(A,N,Q,I,A(INDEX))
C
C   STØRE (L)(A)(L-TRANSPØSE) IN A FØRM SUITABLE FØR SYMEIG
C     WHERE L IS THE INVERSE ØF THE CHØLESKY MATRIX
C
      CALL SWITCH(A,N)
      CALL SYMEIG(A,N,1,NUMEIG,Q,TØL)
      DØ 300 I=1,NUMEIG
  300 C(I) = 1.0/Q(I)
      IF (MSEIG.EQ.0) GØ TØ 301
      DØ 302 I=1,NUMEIG
  302 C(I) = C(I)-ALAMDA
      ANS = C(3)/ALAMDA
```

```
      IF (ANS.GE.1.E-6) GØ TØ 301
      NCHK = 1
      PØW = ANS/1.E-6
      GØ TØ 99
  301 CØNTINUE
      NCHK = 0
      WRITE(6,56) (C(I),I=1,NUMEIG)                                     3600580
   56 FØRMAT(////- EIGENVALUES-/(1P8E15.6))                             3600590
C                                                                       3600600
C   EIGENVALUES ARE IN Q                                                3600610
C                                                                       3600620
      IF (NPAS.GT.1) GØ TØ 600
      J = 1
      MM = 2
      IF (MSEIG.EQ.0) GØ TØ 310
      J = 3
      MM = 4
  310 NN = J
      IF (NUMVEC.EQ.0) GØ TØ 500
      DØ 400 J=MM,NUMEIG                                                3600660
      IF (C(J).LT.0.0) GØ TØ 401
  400 CØNTINUE
      L = NUMEIG
      GØ TØ 410
  401 L = J-1
      IF (L.GT.NN) GØ TØ 410                                            3600720
      J = L
      GØ TØ 500
  410 IF (C(NN).LT.1.0) GØ TØ 411                                       3600750
      J = NN                                                            3600760
      GØ TØ 500
  411 DØ 402 J=MM,L                                                     3600780
      IF (C(J)-1.0) 402,500,501
  402 CØNTINUE
      J = L
  501 IF ((1.0-C(J-1)).LT.(C(J)-1.0)) J = J-1
  500 ISTART = J
      IF (J.EQ.NUMEIG) ISTART = J-1
      IF (NUMVEC.EQ.1) WRITE(6,610) ISTART
  610 FØRMAT(//5X,-THE REQUIRED EIGENVALUE IS NUMBER-,I3)
  600 EIG = C(ISTART)
      IVEC = ISTART+1
      IF (ABS(ABS(EIG)-1.0).GT.CØNV) GØ TØ 99                           3600640
      DØ 30 I=ISTART,IVEC                                               3600660
      CALL SYMVEC (A(INDEX),I,1,N)                                      3600670
      IN=INDEX1+N                                                       3600680
      WRITE(4) (A(IND),IND=INDEX,IN)                                    3600681
   30 CØNTINUE                                                          3600690
      REWIND 4                                                          3600700
      IØFF=1                                                            3600740
      DØ 40 I=1,N                                                       3600750
      J2=IØFF+I-1                                                       3600760
      READ(4) (A(J),J=IØFF,J2)                                          3600770
   40 IØFF=IØFF+I                                                       3600780
      DØ 50 I=1,2                                                       3600790
      READ(4) (Q(J),J=1,N)                                              3600800
      CALL TRIEQ (A,Q)                                                  3600810
      WRITE(6,57)I,(Q(IJ),IJ=1,N)                                       3600820
   57 FØRMAT(//- EIGENVECTØR-,I4/(1P8E15.6))                            3600830
      DØ 70 IJ=1,N                                                      3600831
   70 QVEC(IJ,I) = Q(IJ)                                                3600832
```

```
50 CØNTINUE                                                             3600840
   REWIND 4                                                             3600841
99 RETURN                                                               3600850
   END                                                                  3600860
```

```
FØR,IS DAGGER,DAGGER
      SUBRØUTINE DAGGER(A,M,P,KO,Q)                                     4500010
      DIMENSIØN A(1),P(1),Q(1)                                          4500020
      EQUIVALENCE (SUN,SUM)                                             4500040
      K = KO                                                            4500050
      K1 = K + 1                                                        4500060
      L=1                                                               4500070
      LL = 0                                                            4500080
      INDEX = 1                                                         4500090
      DØ 130  I = 2,K1                                                  4500100
      LJ = INDEX                                                        4500110
      SUM = 0.0
      DØ 90  J = 1,L                                                    4500130
      SUM = SUM + A(LJ)*P(J)                                            4500140
   90 LJ = LJ + 1                                                       4500150
      IF (K - L) 100,120,100                                            4500160
  100 LL = LL + L                                                       4500170
      LJ = LL + L                                                       4500180
      UØ 110  J = I,K                                                   4500190
      SUM = SUM + A(LJ)*P(J)                                            4500200
  110 LJ = LJ + J                                                       4500210
  120 Q(I-1) = SUN                                                      4500220
      INDEX = INDEX + L                                                 4500230
  130 L = I                                                             4500240
      SUM = 0.0
      DØ 140  I = 1,K                                                   4500260
      SUM = SUM + P(I)*Q(I)                                             4500270
      A(LL+1) = Q(I)                                                    4500280
  140 LL = LL + 1                                                       4500290
      A(LL) = SUN                                                       4500300
      IF (M - K)  150, 200, 150                                         4500310
  150 DØ 190  L = K1,M                                                  4500320
      JL = LL+L-K                                                       4500330
      SUM = 0.0
      DØ 180  J = 1,K                                                   4500350
      SUM = SUM + P(J)*A(JL)                                            4500360
  180 JL = JL + 1                                                       4500370
      LL = LL + L - 1                                                   4500380
  190 A(LL) = SUM                                                       4500390
  200 CØNTINUE                                                          4500400
      RETURN                                                            4500410
      END                                                               4500420
```

```
FØR,IS SYMEIG,SYMEIG
      SUBRØUTINE SYMEIG(A,M,INDEX,NUMBR,R,TØL)
C  MASTER RØUTINE FØR EIGENVALUES AND (ØPTIØNALLY) EIGENVECTØRS ØF A
C    REAL SYMMETRIC MATRIX STØRED TRIANGULARLY IN CØRE. THE HØUSEHØLDER
C    REDUCTIØN TØ TRIDIAGØNAL FØRM (SUBRØUTINE TFØRM) IS FØLLØWED BY A
C    BISECTIØN TECHNIQUE (SUBRØUTINE STURM) FØR THE RØØTS AND THEN IN-
C    VERSE ITERATIØN (SUBRØUTINE TRIVEC) FØR THE VECTØRS.
C
C
C  MEANING ØF THE PARAMETERS.
C    A        -  THE TRIANGULAR ARRAY CØNTAINING THE MATRIX. DURING EXEC-
C                  CUTIØN THE ARRAY IS CHANGED.
C
C    M        -  ØRDER ØF A.
C
C    INDEX    -  INDEX ØF FIRST EIGENVALUE REQUIRED.
C
C    NUMBR    - NUMBER ØF EIGENVALUES REQUIRED.
C
C    R        - REAL ARRAY FØR THE RØØTS AND WØRKING STØRAGE. R MUST CØN-
C                 TAIN AT LEAST 8*M WØRDS AND START ØN A D.P. BØUNDARY.
C
C    TØL      - TØLERANCE. IF B IS THE MAG. ØF LARGEST RØØT, THE RØØTS
C                 WILL USUALLY HAVE ERRØRS AS LARGE AS B*TØL.
C
      DIMENSIØN A(1),R(1)
      LD = 1 + M
      LØ = LD + M
      LS = LØ + M
      LP = LS + M
      LQ = LP + M
      LR = LQ + M
      CALL TFØRM(A,M,R(LD),R(LØ),R(LS),R(LP))
      EPS = AMIN1(TØL,1.E-3)
      CALL STURM(M,INDEX,NUMBR,R(LD),R(LØ),R(LS),R(LP),R,EPS)
      RETURN
      ENTRY SYMVEC(X,LØW,KØUNT,MID)
      DIMENSIØN X(MID,1)
      CALL  QSVEC(A,R(LD),R(LØ),R(LP),R(LQ),R(LR),R(LS),M)
      RØØT = R(LS-1)
      EPS = RØØT * 3.E-7
      K = LØW
      DØ 200  I = 1,KØUNT
      RØØT = AMIN1(RØØT-EPS,R(K))
      CALL  QWIEL(RØØT,X(1,I))
  200 K = K + 1
      RETURN
      END
```

```
FØR,IS TFØRM,TFØRM
      SUBRØUTINE TFØRM(A,N,D,Ø,S,P)
      DIMENSIØN A(1),D(1),Ø(1),S(1)
      BL = 0.
      BU = 0.
      ØLD = 0.
      D(1) = A(1)
      K1K1 = 1
      N1 = N - 1
      DØ 230  K = 1,N1
      KP1 = K + 1
      KK = K1K1
      KKP1 = KK + 1
      NK = N - K
      KN = KK + NK
      K1K1 = KN + 1
      SUM = 0.
      DØ 100  KJ = KKP1,KN
  100 SUM = SUM + A(KJ)*A(KJ)
      S(K) = SUM
      RHØ = SQRT(SUM)
      RAD = ØLD + RHØ
      BL = AMIN1(BL,D(K)-RAD)
      BU = AMAX1(BU,D(K)+RAD)
      IF (K - N1) 120,230,230
  120 ØLD = RHØ
      IF (A(KKP1)) 140,140,130
  130 RHØ = -RHØ
  140 Ø(K) = RHØ
      IF (SUM) 150,230,150
  150 A(KKP1) = A(KKP1) - RHØ
      RHØ = 1. / (RHØ*A(KKP1))
      A(KK) = RHØ
      IJ = KK
      DØ 160  J = KP1,N
      IJ = IJ + 1
      Ø(J) = A(IJ)
  160 D(J) = 0.
      II = K1K1
      NI = NK
      DØ 190  I = KP1,N
      D(I) = D(I) + A(II)*Ø(I)
      IJ = II
      II = II + NI
      NI = NI - 1
      IF (NI) 170,190,170
  170 X = Ø(I)
      DØ 180  J = I,N1
      IJ = IJ + 1
      D(J+1) = D(J+1) + A(IJ)*X
  180 D(I) = D(I) + A(IJ)*Ø(J+1)
  190 D(I) = D(I) * RHØ
      SUM = 0.
      DØ 200  I = KP1,N
  200 SUM = SUM + D(I)*Ø(I)
      TAU = RHØ * SUM * .5
      DØ 210  I = KP1,N
  210 D(I) = D(I) + TAU*Ø(I)
      II = K1K1
      NI = NK
      DØ 220  I = KP1,N
```

```
      RHØ = D(I)
      TAU = Ø(I)
      IJ = II
      II = II + NI
      NI = NI - 1
      DØ 220  J = I,N
      A(IJ) = A(IJ) + RHØ*Ø(J) + TAU*D(J)
 220  IJ = IJ + 1
 230  D(K+1) = A(K1K1)
      Ø(N1) = A(KKP1)
      Ø(N) = AMIN1(BL,D(N)-RHØ)
      S(N) = AMAX1(BU,D(N)+RHØ)
      RETURN
      END
```

```
FØR,IS STURM,STURM
      SUBRØUTINE STURM (N,LIM1,NUMB,D,ØFFD,SEC,PFFD,SIGMA,EPS)
      DIMENSIØN D(1),ØFFD(1),SEC(1),SIGMA(1),PFFD(1)
      DATA HALF / .5/
      BL = ØFFD(N)
      BU = SEC(N)
      LIM2 = LIM1 + NUMB - 1
      CALL PREP (N,D,SEC,RØØT,LØRD)
      N1 = N - 1
      IF (N1) 16,200,200
  200 TØL = AMAX1(-BL,BU)
      ØFFD(N) = TØL
      TØL = TØL * AMAX1(1.E-15,EPS)
      DØ 2  I = LIM1,LIM2
      SIGMA(I) = BL
    2 PFFD(I) = BU
      LØRD = 0
      L = LIM1 - 1
      RUTE = 1.E20
      GØ TØ 3
  300 DØ 400  I = K,L
  400 SIGMA(I) = RØØT
    3 K = L + 1
      IF (K - LIM2) 4,4,16
    4 BU = PFFD(K)
      RØØT = BU  +  HALF * (SIGMA(K) - BU)
      IF (K - L) 5,7,5
    5 DØ 6  I = K,LIM2
      IF (BU - PFFD(I)) 7,6,7
    6 L = I
    7 IF (ABS(RØØT - RUTE) - TØL) 300,300,8
    8 CALL DET (N,D,SEC,RØØT,LØRD)
      DØ 11  I = K,L
      IF(I -LØRD) 9,9,10
    9 SIGMA(I) = RØØT
      GØ TØ 11
   10 PFFD(I) = RØØT
   11 CØNTINUE
      RUTE = RØØT
      GØ TØ 4
   16 RETURN
      END
```

```
FØR,IS PREP,PREP
      SUBRØUTINE PREP (N,D,SEC,RØØT,LØRD)
      DIMENSIØN D(1),SEC(1)
      EQUIVALENCE (RD2,RE2),(RD4,RE4)
      N1 = N - 1
      GØ TØ 200
      ENTRY DET (N,D,SEC,RØØT,LØRD)
      RD0 = RØØT
      LØW = 0
      LAWD = 0
  100 RD2 = 0.D0
      RD4 = 1.D0
      DØ 120  I = LØW,N1
      RD4 = D(I+1) - RD0 - RD2
      IF (RD4) 120,140,110
  110 LAWD = LAWD + 1
  120 RE2 = SEC(I+1) / RE4
  130 LØRD = LAWD
      GØ TØ 200
  140 LAWD = LAWD + 1
      IF (RE2) 150,160,150
  150 I = I + 1
  160 LØW = I + 1
      IF (LØW - N1) 100,100,130
  200 RETURN
      END
```

```
FØR,IS QSVEC,QSVEC
      SUBRØUTINE  QSVEC(A,D,ØFFD,P,Q,R,S,N)
C  SYMMETRIC MATRIX EIGENVECTØR CALCULATIØN.
C  GIVEN THE ENTRIES (D AND ØFFD) ØF THE HØUSEHØLDER TRI-DIAGØNAL FØRM B
C    ØF A REAL SYMMETRIC MATRIX A, AND GIVEN A GØØD APPRØXIMATE RØØT ØF
C    B (AND A) THIS FØRTRAN 4 SUBRØUTINE CØMPUTES A UNIT EIGENVECTØR X
C    ØF B, THEN TRANSFØRMS IT TØ A UNIT VECTØR ØF A, USING THE VECTØRS W
C    STØRED IN THE A ARRAY.
      DIMENSIØN A(1),D(1),ØFFD(1),P(1),Q(1),R(1),S(1),X(1)
      DØUBLE PRECISIØN SUM
      CØMMØN /INFØ/ SUM,M,IX,IA
      DATA FLAG/07777777777776/
C
C  PART 1.  PRELIMINARIES.
C
      IX = 1
      IA = 1
      N1 = N - 1
      N2 = N - 2
      RETURN
      ENTRY  QWIEL(RØØT,X)
      ASSIGN 170 TØ KØUNT
      TØL = 0.
      DØ 100  I = 1,N
      P(I) = D(I) - RØØT
      Q(I) = ØFFD(I)
      R(I) = 0.
      TØL = AMAX1(TØL,ABS(D(I)))
      CALL RANDØM (XX)
  100 X(I) = XX+.1
      TØL = (TØL + 1.E-15) * 1.E-15
C
C  PART 2.  MATRIX DECØMPØSITIØN.
C
      DØ 150  I = 1,N1
      T = ABS (P(I))
      U = ABS (ØFFD(I))
      IF (T + U - TØL) 110,120,120
  110 P(I) = TØL
      T = P(I)
  120 IF (T - U) 130,140,140
  130 S(I) = P(I)/ØFFD(I)
      CALL ØRR (S(I),1,S(I))
      TEMP = Q(I)
      P(I) = ØFFD(I)
      Q(I) = P(I+1)
      R(I) = Q(I+1)
      P(I+1) = TEMP - S(I)*Q(I)
      Q(I+1) = -S(I)*R(I)
      GØ TØ 150
  140 S(I) = ØFFD(I)/P(I)
      CALL ANDD (S(I),FLAG,S(I))
      P(I+1) = P(I+1) - S(I)*Q(I)
  150 CØNTINUE
      IF (ABS(P(N)) .LT. TØL)  P(N) = TØL
      GØ TØ 210
C
C  PART 3.  RIGHT SIDE MØDIFICATIØN.
C
  170 ASSIGN 330 TØ KØUNT
      DØ 200  I = 1,N1
```

```
      CALL ANDD (S(I),1,TEMP)
      IF (TEMP) 180,190,180
  180 T = X(I)
      X(I) = X(I+1)
      X(I+1) = T - S(I)*X(I)
      GØ TØ 200
  190 X(I+1) = X(I+1) - S(I)*X(I)
  200 CØNTINUE
C
C  PART 4.  TRIANGULAR SYSTEM SØLUTIØN.
C
  210 X(N) = X(N)/P(N)
      X(N1) = (X(N1) - Q(N1)*X(N)) / P(N1)
      DØ 220  I = 2,N1
      K = N - I
  220 X(K) = (X(K) - Q(K)*X(K+1) - R(K)*X(K+2)) / P(K)
C
C  PART 5. SCALING TØ UNIT VECTØR.
C
  230 SUM = 0.D0
      M = N
      CALL DØTPRØ (X,X)
      SCALAR = DSQRT(SUM)
      DØ 250  I = 1,N
  250 X(I) = X(I)/SCALAR
      GØ TØ KØUNT, (170,330,370)
C
C  PART 6.  TRANSFØRMATIØN BY ØRTHØGØNAL MATRICES.
C
  330 L = (N*(N+1))/2 - 4
      DØ 360  I = 1,N2
      NI = N - I
      SUM = 0.D0
      M = I + 1
      CALL DØTPRØ (X(NI),A(L))
      SCALAR = A(L-1)*SUM
      IJ = L
      DØ 350 J=NI,N
      X(J) = X(J) + SCALAR*A(IJ)
  350 IJ = IJ + 1
  360 L = L - I - 3
      ASSIGN 370 TØ KØUNT
      GØ TØ 230
  370 RETURN
      END
```

```
FØR,IS ANDD,ANDD
      SUBRØUTINE ANDD (X,Y,Z)
      LØGICAL UND,JA,NEIN
      REAL NØ
      EQUIVALENCE (UND,E),(JA,SI),(NEIN,NØ)
      IFLAG = 0
      GØ TØ 1
      ENTRY ØRR (X,Y,Z)
      IFLAG = 1
    1 SI = X
      NØ = Y
      UND = JA.AND.NEIN
      IF (IFLAG.EQ.1) UND = JA.ØR.NEIN
      Z = E
      RETURN
      END
```

```
FØR,IS DØTPRØ,DØTPRØ
      SUBRØUTINE DØTPRØ (X,Y)
      DIMENSIØN X(1),Y(1)
      DØUBLE PRECISIØN S
      CØMMØN /INFØ/ S,N,IX,IY
      IF (N) 120,120,100
  100 JX = 1
      JY = 1
      DØ 110  J = 1,N
      S = S + X(JX)*Y(JY)
      JX = JX + IX
  110 JY = JY + IY
  120 RETURN
      END
```

SUBROUTINE DETERM

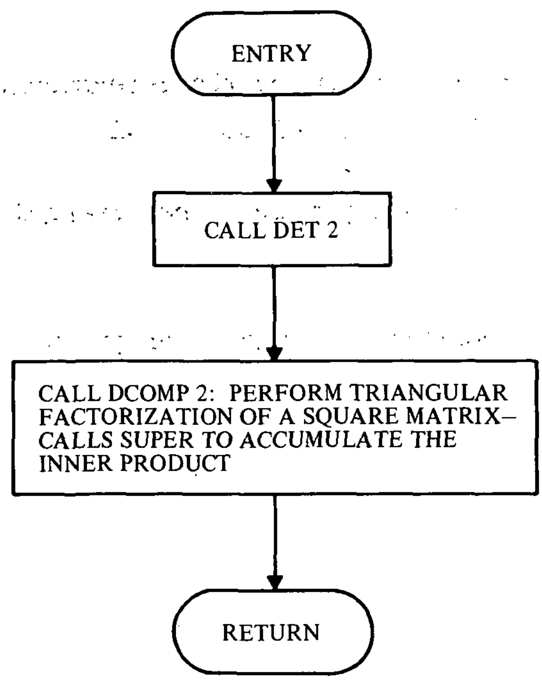
This is the controlling routine for the program determinant evaluation loop. The matrix in question is passed to DET2 where the determinant evaluation calculations occur.

Subroutine DET2: This routine computes the determinant of a square matrix. The actual determinant value is normalized to ±1.

Subroutine DCOMP2: This routine performs the triangular factorization of a square matrix.

Subroutine SUPER: This routine performs inner product accumulation.

DETERM


ENTRY
CALL DET 2
CALL DCOMP 2: PERFORM TRIANGULAR FACTORIZATION OF A SQUARE MATRIX—CALLS SUPER TO ACCUMULATE THE INNER PRODUCT
RETURN

```
FØR,IS DETERM,DETERM
      SUBRØUTINE DETERM (NZ,MDET)
      DIMENSIØN A(128,128),T(256)
      REWIND 4
      DØ 187 I=1,NZ
  187 READ(4) (A(I,J),J=1,NZ)
      CALL DET2 (A,NZ,128,T,NU,D)
      WRITE(6,80) D
   80 FØRMAT(///20X,-DETERMINANT =-,F5.1)
      MDET = D
      REWIND 4
      RETURN
      END
```

```
FØR,IS DET2,DET2
      SUBRØUTINE DET2 (A, M, MID, T, NU, D)
C
C       DETERMINANT ØF A SPARSE IN-CØRE REAL MATRIX, WITH PRØTECTIØN
C       AGAINST ØVERFLØW AND UNDERFLØW.  DETERMINANT IS GIVEN IN A
C       SPECIAL FØRM TØ ALLØW REPRESENTATIØN ØF VERY LARGE ØR SMALL
C       VALUES.
C
C     WITH
C
C          A      -  FØRTRAN DØUBLE ARRAY CØNTAINING THE MATRIX.
C
C          M      -  ØRDER ØF MATRIX A, I.E. ACTUAL NUMBER ØF RØWS.
C
C          MID    -  FIRST DIMENSIØN ØF ARRAY A, I.E. MAX. NØ. ØF RØWS.
C
C          T      -  WØRKING STØRAGE ARRAY ØF AT LEAST 2*M REAL NØS.
C
C          NU, D  -  DETERMINANT IS GIVEN AS (16**NU) * D.
C
C
      DIMENSIØN A(1), T(1)
      EQUIVALENCE (P,IP)
      CALL DCØMP2 (A, M, MID, T, T(M+1), NIX)
      NU = 0
      IF (NIX) 100,110,120
  100 D = 0.
      GØ TØ 999
  110 D = 1.
      GØ TØ 130
  120 D = -1.
  130 MID1 = MID + 1
      MMID = M * MID
      DØ 140  II = 1,MMID,MID1
      IF (A(II)) 150,140,140
  150 D = -D
  140 CØNTINUE
  999 CØNTINUE
      RETURN
      END
```

```
 FØR,IS DCØMP2,DCØMP2
      SUBRØUTINE DCØMP2(A,M,MID,LEAD,ENT,NIX)
C       TRIANGULAR DECØMPØSITIØN ØF A SPARSE IN-CØRE MATRIX.
      INTEGER*2 LEAD
      DØUBLE PRECISIØN S
      DIMENSIØN A(1), LEAD(1), ENT(1)
      DATA MØNE / -1 /
      EQUIVALENCE (EL,L)
      NIX = 0
      EPS = 1.E-6
      MP1 = M + 1
      MMID = M * MID
      MM = MMID + M - MID
      DØ 130  I = 1,M
      DØ 100  IJ = I,MM,MID
      IF (A(IJ)) 110,100,110
  100 CØNTINUE
C       IF LØØP FALLS THRØUGH, RØW I IS ZERØ AND A IS SINGULAR.
      NIX = -(1000 + I)
      GØ TØ 999
  110 LEAD(I) = (IJ - I) / MID  +  1
C       LEAD(I) IS THE CØLUMN INDEX ØF 1ST NØN-ZERØ ENTRY ØF RØW I.
      G = 0.
      DØ 120  KJ = IJ,MM,MID
  120 G = ABS( A(KJ) )  +  G
  130 ENT(I) = 16. / G
      KB = 1
      MK = M
      LAST = 0
      KK = 1
C
C       MAJØR LØØP.  CØLUMN K ØF A IS USED TØ PRØDUCE CØLUMN K ØF L AND
C       U.  ABØVE DIAGØNAL, A ELEMENTS CØNVERT TØ U ELEMENTS.  AFTER
C       PIVØT SELECTIØN (USING PARTIAL PIVØTING WITH IMPLICIT RØW
C       SCALING), THE U(K,K) AND L(I,K) ELEMENTS ARE CØMPUTED.  AN
C       ATTEMPT  IS MADE TØ SUPPRESS TRIVIAL ØPERATIØNS BY SKIPPING THE
C       LEADING ZERØ TERMS IN EACH INNER PRØDUCT.  SUPER DØES THE INNER
C       PRØDUCT ACCUMULATIØN AND IS AVAILABLE IN FØRTRAN AND (360)
C       ASSEMBLY LANGUAGE.
C
      DØ 310 K=1,M
      DØ 140  JK = KB,MK
      IF (A(JK)) 150,140,150
  140 CØNTINUE
C       IF LØØP FALLS THRØUGH, CØLUMN K IS ZERØ AND A IS SINGULAR.
      GØ TØ 998
  150 LØWK = JK
      LØW = JK - KB + 1
      JK = MK
      DØ 160  J = 1,M
      IF (A(JK)) 170,160,170
  160 JK = JK + MØNE
C       LØØP CAN-T FALL THRØUGH.
  170 LAST = MAXO(LAST,MP1-J)
      LASTK = KB + LAST - 1
C       FIRST K CØLUMNS CØNTAIN ALL ZERØS BELØW RØW LAST.
      IK =LØWK
      LIMIT = 0
      G = 0.
      DØ 180  I = LØW,LAST
      G = AMAX1(G, ENT(I)*ABS(A(IK)))
```

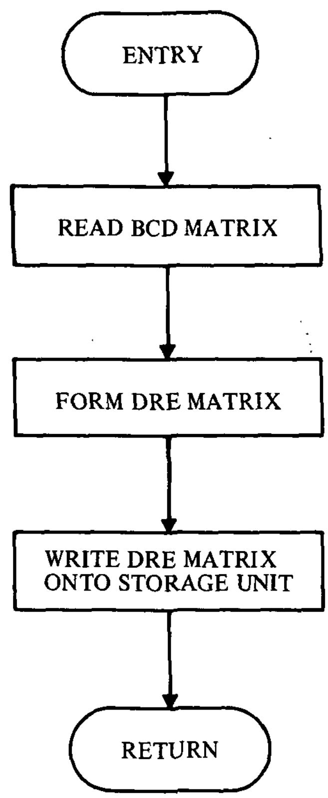
```
180 IK = IK + 1
    TØL = G * EPS
    IK =LØWK
    TØP = 0.
    DØ 230  I = LØW,LAST
    LEAST = LEAD(I)
    LEAST = MAX0(LEAST,LØW)
    CALL SUPER (A(I),A(KB),LEAST,LIMIT,MID,S)
    A(IK) = S+A(IK)
    IF(I - K) 200,210,210
200 LIMIT = I
    GØ TØ 230
210 G = ABS(A(IK)) * ENT(I)
    IF (TØP - G) 220,230,230
220 TØP = G
    L = I
230 IK = IK + 1
    IF (TØP - TØL) 998,240,240
240 G = ENT(L)
    ENT(L) = ENT(K)
    ENT(K) = G
    IF (L - K) 250,270,250
250 LEED = LEAD(K)
    KLEED = LEAD(L)
    LEED = MIN0(LEED,KLEED)
    KLEED = (LEED - 1) * MID  +  K
    LJ = KLEED + L - K
    DØ 260  KJ = KLEED,MM,MID
    TØP = A(KJ)
    A(KJ) = A(LJ)
    A(LJ) = TØP
260 LJ = LJ + MID
    J = LEAD(L)
    LEAD(L) = LEAD(K)
    LEAD(K) = J
    NIX = 1 - NIX
270 KK1 = KK + 1
    LEAD(M+K) = L
    IF (KK1 - LASTK) 280,280,300
280 G = -A(KK)
    DØ 290  IK = KK1,LASTK
290 A(IK) = A(IK) / G
300 KB = KB + MID
    MK = MK + MID
310 KK = KB + K
    GØ TØ 999
998 NIX = -K
999 RETURN
    END
```

```
FØR,IS SUPER,SUPER
      SUBRØUTINE SUPER (X,Y,LEAST,LIMIT,MID,S)
      DIMENSIØN X(1), Y(1)
      DØUBLE PRECISIØN S
      S = 0.0D0
      IF (LEAST - LIMIT) 100,100,120
  100 IX = (LEAST - 1) * MID  +  1
      DØ 110  I = LEAST,LIMIT
      S = S + X(IX)*Y(I)
  110 IX = IX + MID
  120 RETURN
      END
```

SUBROUTINE BCVECT

This routine converts the eigenvector obtained during a converged eigenvalue pass into the form accepted by INITAL. The calculations are identical to those in the latter part of STRMAT, and result in the DRE array.

BCVECT


ENTRY
READ BCD MATRIX
FORM DRE MATRIX
WRITE DRE MATRIX ONTO STORAGE UNIT
RETURN

```
FØR,IS BCVECT,BCVECT
      SUBRØUTINE BCVECT (NZ,QVEC,NØJS,JRTIC,JRSTØP,NREG)                4600010
      DIMENSIØN QVEC(128,1),BCD(128,128),JRTIC(1),JRSTØP(1)             4600020
      DIMENSIØN DRE(128,2)                                              4600021
      REWIND 3                                                          4600030
      REWIND 14                                                         4600040
      NJTNH4 = 4*NØJS                                                   4600050
      READ(14) ((BCD(I,J),J=1,NZ),I=1,NJTNH4)                           4600060
      DØ 800 L=1,2                                                      4600061
      DØ 800 J=1,NJTNH4                                                 4600070
      DRE(J,L) = 0.0                                                    4600080
      DØ 800 K=1,NZ                                                     4600090
  800 DRE(J,L) = DRE(J,L)+BCD(J,K)*QVEC(K,L)                            4600100
      DØ 71 NR=1,NREG                                                   4600110
      DØ 71 K=1,2                                                       4600120
      II = (JRTIC(NR)-1)*4+1                                            4600130
      IF (K.EQ.2) II = JRSTØP(NR)*4-3                                   4600140
      III = II+3                                                        4600150
      DØ 71 I=II,III                                                    4600160
   71 WRITE(3) (DRE(I,L),L=1,2)                                         4600170
      REWIND 3                                                          4600180
      RETURN                                                            4600190
      END                                                               4600200
```

SUBROUTINE ETRAP

This is an error trap routine which can be called by the MAIN routine at various stages of program execution. If the indicator NIX is not equal to zero, MAIN will call ETRAP and indicate the proper message to be printed.

```
FØR,IS ETRAP,ETRAP
      SUBRØUTINE ETRAP
      INTEGER SAVJTC,SAVSTP,Q,THICK
      INTEGER XN
      CØMMØN STØRY(16),XMAT(110,10),STD(10),SADUS(30),RADUS(30)
      CØMMØN TADUS(30),UADUS(30),SAVTIC(900)
      CØMMØN XN,TEFREE,TIC,PHI,STØP,RESTØP,RTICK,G1,XNL(3),NH
      CØMMØN NST(30),NKL(30),NXMAT(20),SAVJTC(30),SAVSTP(30),JRTIC(30)
      CØMMØN JRSTØP(30),NREG,NMPT,NRC,NSC,NIX,IERRØR,KGEØM,IGEØM,ISTTAB
      CØMMØN KELVIN,IBEGIN,NPRØB,NSEG,NERRØR,Q,THICK,NØJS,NLINKS,NLCASE
      CØMMØN NTSKL,NZ,NBCT,LINPUT,NTRKL,NPASS,XN1,KBC,NRINGS
      DØUBLE PRECISIØN SAVTIC,TIC,PHI,STØP,RESTØP,RTICK
      WRITE(6,1726)
 1726 FØRMAT(1H1)
      GØ TØ (8000,8036,8086,8087,8089,8090,8013,8009,8031,8008,8001,
     1       8C02,8003,8006,8007,8067,8101,8102,8103,8104,8105,8106,
     2       8107,8108,8109,8110,8088,110,8120,8841,8842,8777,8797,
     3       8787),NERRØR
 8000 WRITE(6,1)
    1 FØRMAT(/  4X,-ØNE ØF THE MATERIAL PRØPERTY TABLES CANNØT BE IDENTI
     1FIED AS ISØT, ØRTH, ØR STIF.-/)
      GØ TØ 505
 8036 WRITE(6,2)
    2 FØRMAT(/  4X,-A MATERIAL PRØPERTY TABLE NAME FØR A SEGMENT CANNØT
     1BE FØUND IN THE TABLE LIST.-/)
      GØ TØ 505
 8086 WRITE(6,3)
    3 FØRMAT(/  4X,-THE TYPE ØF GEØMETRY ØF A SEGMENT CANNØT BE IDENTIFI
     1ED AS ØNE HANDLED BY THE PRØGRAM.-/)
      GØ TØ 505
 8087 WRITE(6,4)
    4 FØRMAT(/  4X,-THE TYPE ØF MATERIAL PRØPERTY TABLE FØR A SEGMENT CA
     1NNØT BE IDENTIFIED AS ISØT, ØRTH, ØR STIF.-/)
      GØ TØ 505
 8089 WRITE(6,5)
    5 FØRMAT(/  4X,-THE WALL CØNSTRUCTIØN ØF A SEGMENT CANNØT BE IDENTIF
     1IED AS SING, EQUA, UNEQ, ØR BLAN.-/)
      GØ TØ 505
 8090 WRITE(6,6)
    6 FØRMAT(/  4X,-THE TYPE ØF TEMPERATURE INPUT FØR A SEGMENT CANNØT B
     1E IDENTIFIED AS THST, NØTH, THCN, ØR THIN.-/)
 8013 GØ TØ 505
 8009 GØ TØ 505
 8031 WRITE(6,9)
    9 FØRMAT(/  4X,-THE LØAD INDICATØR CLUES CAN ØNLY BE ZERØ, BLANK, ØN
     1E, ØR FØUR.-/)
      GØ TØ 505
 8008 WRITE(6,10)
   10 FØRMAT(/  4X,-THE PRØGRAM CAN EXECUTE ØNLY ØNE THERMAL LØAD PRØBLE
     1M PER DATA DECK.-/)
      GØ TØ 505
 8001 WRITE(6,11)
   11 FØRMAT(/  4X,-THE MAGIC CYCLE HAS GØNE PAST STØP BY MØRE THAN THE
     1PERMITTED VALUE. CHECK TØ SEE IF FIXED STEP SIZE IS TØØ LARGE.-/)
      GØ TØ 505
 8002 WRITE(6,12)
   12 FØRMAT(/  4X,-THE RIEMAN VARIABLE, IEND, WHICH SIGNALS THE END ØF
     1A SEGMENT SHØULD ØNLY BE ZERØ ØR NEGATIVE ØNE.-/)
 8003 GØ TØ 505
 8006 GØ TØ 505
 8007 WRITE(6,15)
```

```
   15 FØRMAT(/  4X,-THE INTERPØLATED VALUE ØF TEMPERATURE FØR THE MATERI 2300610
     1AL PRØPERTY TABLE IS LESS THAN THE SECØND TEMPERATURE VALUE.-/)    2300620
      GØ TØ 505                                                          2300630
 8067 WRITE(6,16)                                                        2300640
   16 FØRMAT(/  4X,-THE INTERPØLATED VALUE ØF TEMPERATURE FØR THE MATERI 2300650
     1AL PRØPERTY TABLE IS GREATER THAN THE LAST VALUE ØF TEMPERATURE.-  2300660
     2/)                                                                 2300670
      GØ TØ 505                                                          2300680
 8101 WRITE(6,17)                                                        2300690
   17 FØRMAT(/  4X,-THE K11 STIFFNESS PARAMETER IS ZERØ.-/)              2300700
      GØ TØ 505                                                          2300710
 8102 WRITE(6,18)                                                        2300720
   18 FØRMAT(/  4X,-THE K12 STIFFNESS PARAMETER IS ZERØ.-/)              2300730
      GØ TØ 505                                                          2300740
 8103 WRITE(6,19)                                                        2300750
   19 FØRMAT(/  4X,-THE K21 STIFFNESS PARAMETER IS ZERØ.-/)              2300760
      GØ TØ 505                                                          2300770
 8104 WRITE(6,20)                                                        2300780
   20 FØRMAT(/  4X,-THE K22 STIFFNESS PARAMETER IS ZERØ.-/)              2300790
      GØ TØ 505                                                          2300800
 8105 WRITE(6,21)                                                        2300810
   21 FØRMAT(/  4X,-THE K33 STIFFNESS PARAMETER IS ZERØ.-/)              2300820
      GØ TØ 505                                                          2300830
 8106 WRITE(6,22)                                                        2300840
   22 FØRMAT(/  4X,-THE D11 STIFFNESS PARAMETER IS ZERØ.-/)              2300850
      GØ TØ 505                                                          2300860
 8107 WRITE(6,23)                                                        2300870
   23 FØRMAT(/  4X,-THE D12 STIFFNESS PARAMETER IS ZERØ.-/)              2300880
      GØ TØ 505                                                          2300890
 8108 WRITE(6,24)                                                        2300900
   24 FØRMAT(/  4X,-THE D21 STIFFNESS PARAMETER IS ZERØ.-/)              2300910
      GØ TØ 505                                                          2300920
 8109 WRITE(6,25)                                                        2300930
   25 FØRMAT(/  4X,-THE D22 STIFFNESS PARAMETER IS ZERØ.-/)              2300940
      GØ TØ 505                                                          2300950
 8110 WRITE(6,26)                                                        2300960
   26 FØRMAT(/  4X,-THE D33 STIFFNESS PARAMETER IS ZERØ.-/)              2300970
      GØ TØ 505                                                          2300980
 8088 WRITE(6,27)                                                        2300990
   27 FØRMAT(/  4X,-THE PRØGRAM CANNØT DETERMINE WHETHER THE PRØBLEM INP 2301000
     1UT IS THIC, RWAF, RWA1, RWA2, RWA3, ST10, ST11, ST12, ST13, ISG1,  2301010
     2ISG2, ØR ISG3.-/)                                                  2301020
  110 GØ TØ 505                                                          2301030
 8120 WRITE(6,29)                                                        2301040
   29 FØRMAT(/  4X,-THE Y2 BLØCK IN THE SEGMENT MAGIC ØUTPUT IS SINGULAR 2301050
     1.-/)                                                               2301060
      GØ TØ 505                                                          2301070
 8841 WRITE(6,30)                                                        2301080
   30 FØRMAT(/  4X,-IN THE CØMPUTATIØN ØF THE REGIØN STIFFNESSES, THE K2 2301090
     12 MATRIX WAS NØT PØSITIVE DEFINITE.-/)                             2301100
      GØ TØ 505                                                          2301110
 8842 WRITE(6,31)                                                        2301120
   31 FØRMAT(/  4X,-IN THE CØMPUTATIØN ØF THE REGIØN LØADS, THE K22 MATR 2301130
     1IX WAS NØT PØSITIVE DEFINITE.-/)                                   2301140
      GØ TØ 505                                                          2301150
 8777 WRITE(6,32)                                                        2301160
   32 FØRMAT(/  4X,-IN THE CØMPUTATIØN ØF THE REDUCED FLEXIBILITY MATRIX 2301170
     1, THE REDUCED STIFFNESS MATRIX IS SINGULAR.-/)                     2301180
      GØ TØ 505                                                          2301190
 8797 WRITE(6,33)                                                        2301200
   33 FØRMAT(/  4X,-FØR KINEMATIC LINKS BETWEEN SEGMENTS, THE DEPENDENT  2301210
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     1JØINT NUMBER MUST BE GREATER THAN THE INDEPENDENT JØINT NUMBER.-/)
      GØ TØ 505
 8787 WRITE(6,34)
   34 FØRMAT(/  4X,-THE NUMBER ØF PØINTS IN THE ST TABLE MUST BE BETWEEN
     1 2 AND 30.-/)
  505 RETURN
      END
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REFERENCES

1. Svalbonas, V., "Numerical Analysis of Stiffened Shells of Revolution - Vol. I: Theory", NASA CR-2273.

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